ARMY ORDNANCE

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

Founded 1920

For Victory Through Armament Production

Volume XXII | MARCH-APRIL, 1942 | No. 131

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(Publication date: February 26, 1942)

Published by the Army Ordnance Association, Suite 705, Mills Building, Washington, D. C. Editor: Lieut. Col. L. A. Codd, Ord. Res.; Associate Editor: R. E. Lewis, Jr. Authors are responsible for statements and opinions expressed in their articles. Copyright, 1942, by the Army Ordnance Association, Washington, D. C. Permission for republication in whole or in part must be obtained in advance.

Issued bimonthly. Single copy 75c (by mail). Subscription rate: continental U. S., $4.50 annually; foreign, $6.00, in advance. Entered as second-class matter, August 14, 1920, at the Post Office at Washington, D. C., under the Act of March 3, 1879. Additional second-class entry at the Post Office at Richmond, Va. Three weeks' notice before publication date of next issue required for change of address.

THE ARMY ORDNANCE ASSOCIATION

The Aims, Purposes, and National Officers of the Society

THE Army Ordnance Association, a national society of more than 10,000 American citizens, was founded in 1919, "pledged to industrial preparedness for war as our nation's strongest guaranty of peace." The society was incorporated under the laws of the District of Columbia in 1928. Its entire energies are now dedicated to victory for the armed forces of the United States. For the duration of the war it is "pledged to victory—complete, absolute, final."

The Association has endeavored during the past twenty-two years to keep alive an interest in and knowledge of the design, production, and maintenance of military armament. This it has done through periods of public lassitude and times of great national emergency. Until 1940 there was no peace-time armament industry in the United States for the production of ordnance. Now all American industry is being geared rapidly for victorious war production.

The principal objective of the society is an active membership of American citizens to assist in the design, development, procurement, production, maintenance, and supply functions of the Ordnance Department of the United States Army. When peace returns this body of informed citizens will again continue to be a bulwark of knowledge, experience, and ability upon whom the Armed Forces of the United States can rely for technical and scientific assistance and for industrial preparedness.

The Association is devoted solely to the national defense; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its elected officers and directors serve without remuneration. Membership, to which American male citizens are eligible, is four dollars a year. (Application on request.) There are eighteen local chapters of the Association throughout the United States.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guaranties of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve officers of the Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

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Our Heavy Tank

ARMY ORDNANCE

Volume XXII MARCH-APRIL, 1942 No. 131

Industrial Mobilization

Progress in the Light of Established Principles

Robert P. Patterson*

THE responsibility of the Planning Branch of the Office of the Under Secretary of War has been to develop sound policies for military procurement and to prepare plans for efficient industrial mobilization in time of emergency. To expedite procurement, the branch has acted to clear specifications for items of military importance and to encourage standardization and simplification. Commodity plans have included measures for procurement of important materials, including strategic and critical materials. Plans for industrial mobilization included an inventory of industrial capacity and equitable apportionment of defense needs to that capacity.

That this planning, developed throughout the past twenty years, has been fundamentally sound is shown by the numerous obstacles it has uncovered and removed. Manufacturers, forewarned of the tasks contemplated for them, made early preparation to provide the necessary labor, tools, and raw materials, and recognized the necessity for projecting requirements well ahead of the time of actual need. However, numerous new developments caused many changes in the plans and proved fully that their flexible underlying principles were sound. The continuation of peace-time regulations requiring competitive bidding and award to the lowest bidder made it impracticable to place munitions orders with previously selected sources as envisioned by the allocation system. Valuable capacity, earmarked for one type of production, in many cases was converted on short notice to produce other items.

Emphasis on motorization, aviation, and mechanization threw a burden on the machine-tool and metal-working industries far in excess of any heretofore visualized. The unpredictable implications of the Lend-Lease Act further complicated the task of computing definite requirements as a basis for procurement activities. The search for facilities for the production of problem items was increased both in tempo and scope by the requirements of the British program. All these problems had to be and were successfully adapted to the procurement and industrial-mobilization plans already made.

The standards division of the Planning Branch has speeded procurement through its handling of specifications and its promotion of standardization and simplification. In the past, it was difficult to determine the suitability of an item for mass production owing to the limited quantities manufactured in peace time. The large orders now being placed make it necessary that these problems be solved quickly and efficiently beforehand. It has been assisted in its activities by various outside agencies such as the Bureau of Standards, the American Standards Association, the American Society for Testing Materials, and others.

The commodity plans of the branch have resulted from studies of all basic commodities. Up-to-date requirements for these commodities have been consolidated from statistics furnished by the supply arms and services. They include requirements for 14 strategic, 15 critical, and about 40 other essential materials, as well as some 200 industrial chemicals and 150 drugs. In coöperation with other agencies, the commodities division concerns itself with the conservation of strategic and critical materials, the substitution of other materials when practicable, and the building of stock piles.

AS part of its industrial-mobilization planning activity, the branch surveyed industrial capacity and directed the apportionment of the defense load to that capacity. A continuing effort has been made to use the industrial inventory to insure a wide distribution of the munitions load on one hand and timely procurement on the other. This record of potential capacity, based on plant surveys, is compiled geographically and by industry, and has provided a valuable yardstick for measuring the results attained to date in the current defense program. The overlapping of functions of various field agencies engaged in stimulating production has been prevented by providing a central office of record. Each activity has been kept informed of the progress of the program as a whole, and the plans of all procuring agencies requiring the same kind of industrial capacity have been coordinated. All forward plans were required to be based on maximum utilization of existing plants and facilities, with the building of new capacity only as a last resort.

Forward planning is thus aiming toward both immediate and future munitions capacity and at the same time holding to a minimum the dislocation of the normal geographical pattern of industry. That this pattern has not been disturbed is shown by a comparison of indices of contract awards as of June 1, 1941, and 1937 production. All areas are participating in the program generally in proportion to their potential capacity. The picture of the Cleveland district is distorted by the fact that machine tools, its biggest product, are bought by manufacturers and not on Government contracts. Both Richmond and San Francisco reflect the shipbuilding program, with the latter also reflecting airplane expansion on the Pacific Coast. In coöperation with other interested agencies, the branch has encouraged the use of subcontracting to help distribute the defense load.

Appreciable time has been saved in the procurement program as a result of educational orders placed with industry, whereby a plant "tools up" and becomes adept in making noncommercial articles. Actual deliveries of finished

*The Under Secretary of War. Extracts from the annual report of the Under Secretary of War for the fiscal year 1941, with particular reference to the Industrial Mobilization Plan.

items for use of the Army have been speeded up six to twelve months. Signal recognition of the value of educational orders came from the President in April 1941 in his approval of their use in the bomber program. Increased productive capacity and quicker delivery of airplanes were assured the Air Corps through placing educational orders with automobile and automotive-equipment manufacturers for component parts of bombers. These educational orders will enable manufacturers speedily to adapt their plants to the mass production of airplane parts badly needed in the new bomber-assembly plants.

THE use of facilities equipped by educational orders with knowledge and productive capacity has saved money as well as time. For example, in production contracts totaling approximately $24,000,000 placed by the Chemical Warfare Service as of April 1, 1941, it is estimated $4,000,000 was saved by the use of facilities trained by educational orders. One of the Ordnance Department educational-order contracts, placed in 1939, called for the machining of 10,000 75-mm. high-explosive shells at a price of $84,000, of which $50,000 was for jigs and dies which became the property of the Government upon completion of the contract. An order placed in 1940 for 2,000,000 of the shells resulted in the saving of over 5 months in completing the order. Similarly, the use of educational orders in the initial private manufacture of the Garand rifle saved a year in delivery time and recouped, on the first large-scale orders, approximately $1,000,000 of the educational-order cost of about $1,200,000.

The use of educational orders for conversion and expansion of existing private manufacturing facilities has been of immeasurable value in creating productive capacity for non-commercial military items. The program to date has involved 125 prime contracts distributed in 26 States.

The industrial measures of the national-defense program have given rise to many studies for the purpose of coördinating the industrial military effort with our civilian economy. In coöperation with other interested agencies, the Planning Branch has studied housing, power, labor, transportation, and other factors. . .

The bottlenecks that developed in the defense production program have not come as a surprise to the War Department. Efforts during the past twenty years to conform our requirements to existing industrial capacity disclosed the fact that in machine tools, optical instruments, armor plate, ammunition, and other highly specialized fields of production, our requirements could be met only after a considerable delay. It was these shortages that formed the basis for the educational-orders program and for our continued recommendations for the procurement of stock piles of strategic and critical materials.

Putting our industrial-mobilization plans into operation during the past year has not been a simple operation. The plans were purposely made flexible. It was known that unforeseen factors would develop when the emergency came. Among these factors may be listed the following: (1) The basic industrial-mobilization plan was not placed in operation at the outset of the emergency. (2) The battlefield experience in Europe resulted in changes in military organization and changes in equipment, particularly with respect to motorization, mechanization, and aviation. The military requirements in certain categories were increased tremendously. (3) The passage of the Lend-Lease Act and the adoption of the "arsenal of democracy" policy made unusual and unpredictable demands upon our industrial capacity and our raw-material and labor resources.

The effect of these and other factors was similar to an upward major revision of the man-power mobilization plan. The result was to increase the kind, quantity, and rate of production of finished munitions. This in turn required additional productive capacity and additional raw materials. . .

Our situation at the end of the fiscal year may be summed up as follows: Munitions contracts greater than at any period in our history, except in 1918-1919, had been placed with industry by the War Department. The creation of additional productive capacity, by expansion, conversion, and new construction, was well under way; the greater part of our requirements and the times of delivery were known, and our industrial inventory informed us not only who could best produce the munitions required, but what expansions, conversions, and new capacity were necessary in each case. The stock piling of strategic materials had been accelerated to the extent permitted by available shipping—our commodity plans indicated what imports must be increased and approximately in what amounts. While the Industrial Mobilization Plan, 1939 revision, was not put into full operation, it was followed very closely in War Department procurement activities. From August until the organization of the Priorities Super-Agency in the latter part of December 1940, the Army and Navy Munitions Board exercised the war-time priority function (on a purely voluntary basis by industry, but nevertheless effectively); in our Industrial Mobilization Plan, careful attention had been devoted to this as well as to the other war-time super-agency functions. . .

THE problems remaining at the close of the fiscal year were the completion of munitions orders already placed and the continuation of forward planning to insure the availability of industrial capacity and raw materials to meet future unpredictable requirements. In the solution of these problems, it is believed necessary that: (1) The industrial-mobilization plan be put into full operation; (2) The utmost flexibility be maintained in procurement activities; (3) Forward planning to develop and maintain full data on available, prospective, and potential industrial productive capacity be intensified; (4) The stock-piling program be speeded and conservation, reclamation, and substitutive measures with respect to strategic and critical materials be made mandatory; (5) Serious and early consideration be given to the curtailment of non-essential production in order to free industrial capacity for additional munitions production and to conserve raw materials, transportation, electric power, and labor.

In a country like ours, the munitions burden must be carried by private industry. The big problem of 1940-1941 was the placing of contracts. In less than one year, the War Department placed contracts for nearly thirteen billions of dollars. In 1941-1942 the matter of placing contracts will still be a serious consideration, but the lessons we have learned, the procedures we have established, should facilitate this work considerably. The big problem of 1941-1942 is production. Contracts have been let totaling billions of dollars. The wheels of our national-defense machinery are turning. They must turn ever faster to give America and those countries whose defense we are aiding the muntions they need. This is a great task, and we will carry it out according to American tradition—which means that we must not only equal the records made by industry during the past twelve months, but we must make it our rule to pass them.

Army Motor Transport

Development and Maintenance of Our Chief Military Vehicles

Maj. Gen. Edmund B. Gregory*

THE world's greatest battles have been won by the armies that transported their men and supplies the fastest—got there "fustest with the mostest men." The wheel—the device that gets the men there today—was known in Europe centuries before the birth of Christ, but it was unknown in the Americas when they fell before the onslaught of European conquerors. Despite this initial ignorance, America today has brought the wheel to its highest development in the motorized and mechanized forces that will preserve our civilization.

Army motor transport is depending on the thirty-three years' experience of the Quartermaster Corps to start and keep it rolling. An experimental truck was studied by the Army as early as 1907. In 1916 it was decided that motor transport might be useful to General Pershing in his campaign against Villa on the Mexican Border, and the first truck company was organized.

Automobiles and trucks were coming into their own when the United States entered the World War of 1917, and the Army emerged from that conflict with a huge motor-transport program involving some 216 different makes and designs of vehicles, many of them foreign. We learned a lot about maintenance, repair, and parts replacement in that war —learned it the hard way—and were convinced that probably the most important key to efficient operation is standardization.

The Quartermaster Corps is now procuring trucks and passenger vehicles to meet the requirements of an Army of over 1,800,000 men. However, the current program has sufficient flexibility to permit further expansion.

The Quartermaster Corps has made the Army the largest fleet operator in the country. It buys all the general-purpose vehicles such as ambulances for the Medical Corps, radio cars for the Signal Corps, small-arms repair trucks for the Ordnance Department and truck-tractors for the Corps of Engineers. The Quartermaster Corps itself operates and maintains every kind of motor transport from motorcycles and passenger cars through a wide variety of trucks ranging from the ¼-ton "jeep" to the massive 6-ton jobs which can pull an 8-ton load, like a gun or trailer, in addition to carrying their rated payloads.

The majority of our vehicles are trucks, of course, which do most of the Army's hauling. Briefly, Quartermaster Corps vehicles fall into the following categories (Such designations as "4 x 4" mean that the vehicle has four wheels and that all four wheels are power-driven.):

The ¼-ton, 4 x 4, truck.—This vehicle, known as a "jeep," has almost unlimited uses (Fig. 1). Primarily, however, it is a light-weapon and personnel carrier for the Infantry. It may be used as a combat vehicle since it can tow into action the 37-mm. antitank artillery weapon weighing approximately 800 pounds. It also is used as a command-reconnaissance car.

The ½-ton, 4 x 4.—This vehicle is fitted with a wide variety of bodies to serve as a command, reconnaissance, pickup or radio truck, as an Infantry weapons carrier, or as a cross-country ambulance (Fig. 5). It also can tow a 37-mm. gun.

The 1½-ton, 4 x 4.—This is a general-purpose truck which may be used as a prime mover for 75-mm. field guns (Fig. 6).

The 2½-ton, 6 x 6.—This vehicle is the basic Army truck (Fig. 2). It is manufactured in two wheel bases as a general-purpose vehicle, cargo carrier, gasoline tanker, and prime mover for the 75-mm. field gun and the 105-mm. howitzer.

The 4-ton, 6 x 6.—This vehicle is used primarily for towing 155-mm. howitzers and as a wrecker or general-purpose vehicle (Fig. 7).

The 6-ton, 6 x 6.—This vehicle is the prime mover for the mobile 3-inch and the 90-mm. antiaircraft guns (Fig. 8).

The 4-5-ton, 4 x 4, tractor-truck.—This vehicle is used for towing semitrailers, such as fueling units for the Air Corps, combination cargo and animal carriers for the Cavalry, and trailers loaded with spare parts for Quartermaster companies (Fig. 3).

The 5-6-ton, 4 x 4, tractor-truck.—This vehicle's semitrailers carry various bulky loads such as the Corps of Engineers' topographical unit and ponton trailer unit. The tractor is shown in Fig. 4.

DESPITE their widely divergent uses, all these trucks have certain things in common. Each embodies certain specific military characteristics, including maximum ground clearance, careful balance between gross weight and tire-contact area, and angles of approach and departure of about forty-five and thirty degrees, respectively. The Army truck provided for tactical purposes must be prepared to go wherever the troops go—across country, swamps, shelled areas, anywhere—to get men, guns, food, and ammunition wherever combat troops and artillery may be located.

To meet such conditions, several important and fundamental characteristics have proved essential to military motor vehicles. First and foremost is the adoption of all-wheel drive. Even the tiny "jeep" has this improvement, which gives traction on every wheel and has just about eliminated the familiar World War picture of an Army truck stuck in the mud. To prepare for the rare occasion when they do get bogged, the trucks are equipped with power-driven winches which will pull them out by their own bootstraps. All Army tactical motor vehicles with all-wheel drive have a front-axle declutching device which permits the front-axle drive to be disengaged when operating on dry, hard-surfaced roads where the extra traction is not necessary. A 6-wheel vehicle can have three power-driven axles and ten tires on the ground, which number can be increased to twelve by using dual front wheels.

Another early commercial development adopted by the Army is the "bogie" axle, a device which allows each axle to act independently, thereby relieving structural strains by compensating for uneven terrain. The bogie axle, of course, is most important to the larger trucks, such as the big 6-tonner.

To keep Army trucks moving through deep sand and mud where traction is most difficult, they are equipped with traction devices on the rear wheels which get a grip like a

*Quartermaster General, U. S. Army.

The Army's Principal Transport Vehicles

FIG. 1. ¼-TON, 4X4, TRUCK ("JEEP")

FIG. 5. ½-TON, 4X4, TRUCK

FIG. 2. 2½-TON, 6X6, TRUCK

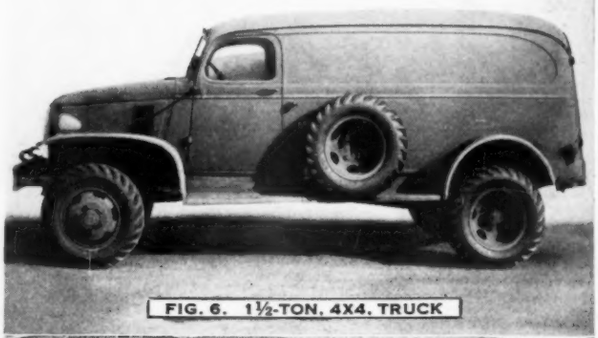

FIG. 6. 1½-TON, 4X4, TRUCK

FIG. 3. 4-TON, 4X4, TRACTOR

FIG. 7. 4-TON, 6X6, TRUCK

FIG. 4. 5-TON, 4X4, PONTON TRACTOR

FIG. 8. 6-TON, 6X6, TRUCK

tank and carry the truck just about anywhere the law of gravity permits. Other military requirements include adjustable windshields, radiator and headlight brush guards, towing hooks and pintles, special front and rear bumpers, series-parallel switches, and special spare-tire and fuel-tank mountings.

In order to be somewhat more specific, it might be well to describe two of the widely used Army trucks—the ¼-ton, 4 x 4, "jeep," and the 1½-ton truck. The ¼-ton has a payload allowance of 800 pounds, including the operating personnel and military supplies. It can tow a 1,000-pound load mounted on two pneumatic-tired wheels. It has a maximum wheel base of 80 inches, a 4-cylinder water-cooled engine with a minimum piston displacement of 110 cubic inches. The tires are 6.00 x 16 inches. The trucks have a maximum speed of 50 miles an hour and a level-road minimum speed of 3 miles an hour. They can ford water at least 18 inches deep at 3 miles an hour. The transmission provides three speeds forward and one in reverse. The 2-speed transfer case has a high range of 1.0 and a low range of 2.0 to 1. Other features include spiral-drive rear axle with gear reduction of 4.75 to 1, 4-wheel hydraulic service brakes, with hand-operated parking brake, and battery and coil ignition. The "jeep" is designed specifically for tactical service and has a base mounting for a machine gun.

The 1½-ton model has a payload capacity of 3,300 pounds including the operating personnel and military supplies. It tows 4,000 pounds on a single-axle trailer mounted on pneumatic tires. It has a wheel base of approximately 145 inches and uses 7.50 x 20 tires on its single front and dual rear wheels. A 6-cylinder engine, with a minimum piston displacement of 235 cubic inches, gives this vehicle a maximum speed of 45 miles an hour and a minimum of 2½ miles an hour. The transmission provides four speeds forward and one in reverse. The front and rear axles are of the full-floating type, the differentials are of the semilocking type. The fuel tank carries gasoline for several hundred miles. The 4-wheel service brakes, hydraulic with a vacuum booster, can hold the fully equipped and loaded truck on a 65-degree grade and bring it to a complete stop within 25 feet from a speed of 20 miles an hour on a dry, hard, approximately level road. This chassis is for use with either a cargo, dump, panel, or delivery body, or a fifth wheel may be mounted on it for use as a truck-tractor.

General-purpose Quartermaster vehicles are divided into two general classes: those required for tactical purposes and those required for administrative purposes. Tactical vehicles usually have all-wheel drive; administrative vehicles may have two or three axles, but they generally have rear-wheel drive only. The passenger car obviously has a limited use, and the motorcycle with sidecar, though a speedy and economical means of transportation, is rapidly giving way to the "jeep."

Many a battle has been lost in the past, and the course of history has often been changed because men and supplies could not get across a river or sea. Moses and the children of Israel, for example, never would have escaped the Egyptians if Pharoah's chariots had been able to float after the waters of the Red Sea had closed in. All this indicates the need for a vehicle that will travel in water as well as on land —an amphibian. Such a vehicle is now undergoing tests. An amphibian eliminates delays for loading and unloading on each bank and thus minimizes the danger of air and artillery bombardment. The amphibian, which can enter the water immediately, propel itself across, and then climb right out with its load, may be the Army's answer to this age-old military problem.

COMBAT and administrative vehicles are not, however, the only product of the Army motor transport service. Mobile shops are among the latest developments. Almost every type of repair-service equipment is now mounted on a truck or trailer and can follow troops right into the field. Motor-repair shops that can handle any kind of a breakdown and mobile service trucks are outstanding types. Army clothes are now washed in mobile laundries and Army personnel in mobile shower baths. Army appetites are satisfied by food prepared in mobile kitchens and bakeries, and Army clothes, shoes, and equipment are repaired in mobile tailor and cobbler shops. A combination commissary and post exchange on wheels now gives the soldier his smokes and candy as easily on maneuvers as he can get them on the post. This unit is mounted on a 2½-ton standard Army cargo truck equipped with cabinets, shelves, steps, and an awning. The cabinets have 250 bins divided into 4 sections and hold about 60 separate items of merchandise. With 4 specially trained attendants, each truck is able to handle the needs of approximately 8,000 men. During halts on the march it can be set up in 15 minutes.

It will not be surprising if the Army's growing fleet of shower baths on wheels proves to be the greatest morale booster yet developed. In these mobile units the soldier can take a shower while his clothing is being "deloused" with steam under heavy pressure. Walking out after a refreshing bath and donning spick-and-span clothing he should be in a frame of mind to meet all comers. We estimate that a sterilization and bath company can take care of about 2,500 soldiers daily.

The new wheeled laundry is made up of small independdent units which can be rapidly dispersed and concealed during air attacks. If the individual units are disabled, the remaining ones can continue operating, or companies may be broken up if desirable to serve widely scattered troops. It is estimated that 16 of the new individual units can service approximately 16,000 men a week. These units are mounted on semitrailers. The laundry equipment receives electrical power from a motor generator, and an oil-burning boiler provides necessary steam.

The basic operating unit of the mechanized cobbler and tailor "shop" which travels with the troops is a section of three separate mobile units—one for repairing shoes, one for clothing, and a third for textile equipment such as mosquito bars, blankets, and tentage. A company of 12 trailers will look after about 48,000 men. A gasoline-driven generator provides power for the electrical repair machinery, all of which, with the other necessary equipment, including two tents, is carried in the repair trailer. The tents are set up at the ends of the trailer to serve as receiving and shipping sections of the repair unit. The repair unit itself is a standard semitrailer with doors at both ends and three windows along each side. To balance the weight, repair equipment is installed along both sides, and supplies are carefully distributed in cabinets and under benches.

Similar thought was given to weight balance in all other mobile repair and service units operated by trained men. They include extremely heavy machine repair shops equipped with power-driven lathes and wide varieties of tools which require careful mountings and especial attention to weight distribution.

Such mobile facilities as these are essentially a development of the gasoline era and were unknown in previous military history. While less spectacular than the dive bomber and the tank, they represent fully as advanced a military achievement. Like everything else on wheels, however, their value depends on their ability to keep moving. It is the task of the Quartermaster Corps not only to furnish the Army with motor-transport service but to keep the Army's vehicles rolling. That means supply and maintenance, both of which involve some ticklish problems in these days of swift-moving warfare over all kinds of terrain.

THE motor-transport supply problem is essentially one of getting fuel, lubricants, and spare parts to the motor vehicles wherever they may be. Supply is being tackled from every angle and the Army believes it has solved the problem. Most of the Army vehicles have large fuel tanks to begin with, and a recently developed 5-gallon container can be mounted in convenient places on a truck to augment the fuel supply. Naturally, however, it is impossible for any Army motor vehicle to carry enough gasoline for an indefinite period. This disadvantage must be offset by a rapid supply system that can deliver fuel to the field promptly enough to prevent delays.

Whenever feasible, the Army uses tankers for transporting fuel by water and railroads for transporting fuel by land. When neither is practicable, tank trucks are used, and when tank trucks have gone as far as possible, 5-gallon containers carried on trucks are employed. Sometimes, of course, it is not possible for a truck to get over the terrain with the necessary promptness. To overcome this obstacle, the Quartermaster Corps is testing a portable pipe line that will carry fuel over hills, down dales, and across rivers, where trucks would be virtually helpless. Portable pipe lines can shuttle gasoline between the base course of supply and convenient distribution points with less exposure to air and artillery attacks than other fuel carriers. The pipe lines come in self-contained half-mile units, each complete with a centrifugal pump driven by a 20-horsepower gasoline engine. They are capable of delivering gas through swamps, forests, over mountains or across water at a rate of approximately 200 gallons a minute.

For ship-to-shore service, one of the new developments is a 5,000-gallon floating gasoline tank which is especially designed to assist in setting up an initial fuel storage supply on a shore. This tank may be floated ashore either empty or full. It may be used in conjunction with the portable pipe line.

The maintenance problem is just as complex as supply. When tens of thousands of trucks and cars are operating in the field, a tremendous organization is required to keep them rolling. The Quartermaster Corps is building such an organization both behind the lines, in great motor maintenance and repair centers, and in the field of operations where the mobile repair units are constantly proving their value.

The center of the vast organization that procures, maintains and operates Army motor vehicles is the Motor Transport Division of the Office of the Quartermaster General in Washington. Spreading out from the Washington headquarters are the eight motor supply depots scattered throughout the United States to furnish motor supplies and spare parts, the depot companies that carry parts to the field, the light- and heavy-maintenance companies that maintain the vehicles, the truck companies that operate them, and the various repair shops, training schools, and other facilities.

Proper maintenance necessarily requires trained drivers, skilled mechanics, and a supply of tools and spare parts. The Army has them all and is getting more continually. Vast numbers of motor-transport specialists are being trained at the motor-transport schools at Holabird, Md.; Fort Normoyle, Tex.; Fort McPherson, Ga.; Stockton, Calif.; Fort Wayne, Mich., and at the Quartermaster replacement training centers at Camp Lee, Va., and Fort Francis E. Warren, Wyo.

The emphasis on standardization has anticipated and thus far forestalled many motor difficulties commonly encountered in the past. The resulting interchangeability of parts has simplified repairs and replacements and is keeping road delays and repair tie-ups to a minimum. Gasoline and oil have been standardized, too, so that only one type of gasoline, three grades of engine oil, two types of greases, and one type of gear lubricant are needed for all kinds of operation.

The supply and maintenance organization and the standardization program represent steps we have taken before the Army motor vehicles even start to run. Prior to procurement, prospective models are tested exhaustively over grueling proving grounds at the Holabird Quartermaster Depot that expose any potential weakness. Faults must be remedied by the manufacturer before the final product is delivered to the Army. Consequently, military vehicles are the toughest, ablest, and strongest the combined talents of the Army and the motor industry can produce.

THE Army's theory is that the best way to keep trucks rolling is to make every one along the line, from top to bottom, do his part. Consequently, motor-vehicle maintenance is divided into four echelons, starting, logically, with the duty of the driver and assistant driver.

First-echelon maintenance means driver preventive maintenance. Every driver must see that his vehicle is correctly loaded, properly operated, adequately lubricated, fueled, and in good repair. Careful driving to avoid unnecessary wear and tear and to conserve fuel is a natural accompanying responsibility.

The second echelon is organizational preventive maintenance. It includes minor adjustments, seasonal check-ups, small replacements, and supervision of first-echelon maintenance. The company mechanics handle this work with the aid of light repair trucks equipped with air compressors, tool kits, and parts cabinets.

The third echelon specializes in unit replacement, which means replacing a faulty unit with a good one rather than taking time to repair it. This puts trucks back into operation in the shortest possible time. It keeps the second echelon supplied with parts and operates a mobile motor repair shop on wheels. The primary function of the third echelon is to collect crippled vehicles and return them to their organization in a serviceable condition or replace them as soon as possible.

Fourth-echelon work is performed by heavy-maintenance companies in stationary or semimobile shops. They can tear down and repair unit assemblies; repair, rebuild, reclaim, and salvage vehicles, and store and issue parts and supplies. These companies have specialist mechanics of various types necessary for the heaviest repair work in the Army.

Briefly stated, this is the plan of the Quartermaster Corps for Army motor transport: To buy better motor vehicles than any other army; to have more and better trained drivers and mechanics, and, by effective supply, operations, and maintenance, to "Keep 'em rolling!" An Army so equipped can win.

Supertanks

Developments Leading to the New Heavy Weapon

Brig. Gen. G. M. Barnes*

EVERY day of battle in the current world war adds emphasis to the fundamental importance of tanks in modern warfare. The two prima donna weapons of the present European war have been the airplane and the tank; however, neither of these weapons has proved to be completely effective without the assistance of the other. The Germans in Poland, France, and elsewhere have won quick and decisive battles when these two weapons have been used in mutual support of each other. On the other hand, where the airplane has been forced to act alone, as in the battle for England, the results have not been decisive.

Under the *Blitzkrieg* method of employing airplanes and tanks, the former are first used to soften the enemy; then tanks follow up the advantage with mass attacks concentrated for a break-through. Being highly mobile, the tanks can attack the weakest part of a long defensive line. It is very difficult for an army on the defensive to stop a massed attack of tanks with antitank guns spread out to defend a long line. Pill boxes and other defensive strong points with antitank guns capable of penetrating a tank's armor usually are carefully avoided by tanks in such an attack. It is probably true that the best defense against a determined tank attack is an equally determined offensive with an equivalent or larger number of opposing tanks.

The layman, in endeavoring to make a comparison between foreign and American tanks, is often confused by the rather loose classification of tanks into light, medium, and heavy types. Under the classification of light tanks, European countries often include vehicles weighing from five to six tons as compared with the American standard light tank of fourteen tons which would be classified as a medium tank in some foreign countries. It is also well to remember that a large percentage of foreign tanks are now of obsolescent models while the tanks with which our armies are now being equipped are of the very latest patterns.

The design of a tank, like that of any other piece of machinery, is a question of making satisfactory compromises between the various conflicting characteristics of the vehicle and is necessarily based upon military requirements. The military characteristics which must be considered are: armament, armor protection, mobility (including trench-crossing ability, maneuverability, speed, and radius of action), weight, number of men in crew, and speed of production. All these basic characteristics, of course, are interdependent, one upon the other.

The problem of the military tank designer is to balance these conflicting characteristics. As the designer does not know the tactical situation under which the tank is to be employed, he strives to make a type of vehicle which will most nearly fit the probable situations which may be encountered in warfare.

The purpose of any tank is to carry safely the guns, ammunition, and personnel necessary for their operation to the desired point in the minimum of time in order that these weapons may be brought to bear effectively and decisively upon the enemy. Tanks must have armament capable of performing the following general missions: (1) The penetration of armor plate, which is best accomplished by high-velocity, low-trajectory weapons involving the use of high-quality armor-piercing ammunition; (2) High-explosive demolition, which is most effectively accomplished by a low-velocity thin-walled projectile; (3) Operation against personnel targets, which are most effectively overcome by small-caliber machine-gun fire; (4) Antiaircraft fire, which involves precision firing against the high-speed airplane moving in three dimensions through space.

THE desire of the tank designer to equip his tank with a large number of high-power weapons is quickly restricted by the number of men in the crew, the space available for guns and ammunition, and by the limitations of weight. To provide space to serve effectively the several types of weapons required may result in a vehicle which has a large silhouette and which is too heavy if the desired armor protection is maintained.

While this subject of armament is confidential as to detail, I am very happy to report that during the last year such rapid progress has been made toward solution of these problems that improvements in the accuracy of fire of our tank weapons of over 1,000 per cent has been possible.

The armor carried by the tank makes it possible for the vehicle to live on the battlefield. Naturally, the designer would like to equip his tank with armor of such thickness that it would be impossible for any type of projectile to penetrate it. It is always a great disappointment to the layman to learn that the armor of any tank can be penetrated, and perhaps this was one of the factors which held back the universal acceptance of tanks for many years. It was always easy to reason that the tank was a very vulnerable vehicle and that its armor could be penetrated readily.

In these arguments against the tank as a fighting vehicle, the principle of employment *en masse* was too often overlooked. Armor provides protection and cover for the working mechanisms and personnel. It is of interest to note that, according to World War records, sixty per cent of battle casualties resulted from low-velocity fragments thrown from projectiles. It is, therefore, obvious that even thin armor provides a great degree of protection. Armor, unfortunately, is the greatest weight-producing factor in a tank and offers the greatest problems in machining and fabrication.

It is the present practice of the United States Army to use rolled face-hardened armor plate. This type of plate gives the greatest protection from small-caliber bullets up to caliber .50. However, it is not well suited to withstand the shock of larger-caliber projectiles. For lightly armored vehicles it is necessary to use face-hardened plate because this is the only type of thin plate which will keep out the bullets from high-powered machine guns.

Rolled homogeneous plate offers the best ballistic values against projectiles larger than machine-gun bullets. It fur-

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The New Ordnance Heavy Tank Has Superior Fire Power

nishes protection against small-arms bullets which cannot penetrate so great a thickness and is also a superior type of plate for absorbing the shocks of heavier-caliber cannon projectiles. It can be welded and formed.

The use of cast armor in the United States is increasing. Up to the present time, cast armor has been made to give about ninety per cent of the ballistic value of rolled homogeneous plate. Cast armor has an important design advantage in that it can be contoured and sloped to any desired shape and thus achieve some advantage in ballistic values.

Tank plates may be riveted or welded together. While we completely welded a tank as early as 1933, and while we have made armor-plate castings at Watertown Arsenal over a long period of years, welding and casting have entered the field of design extensively only during the last year. The urge to weld or cast comes largely from the desire to eliminate riveted structures which are somewhat weak ballistically. The rapid development in welding armor during the past year insures that welding will be extensively used in tank manufacture in the future.

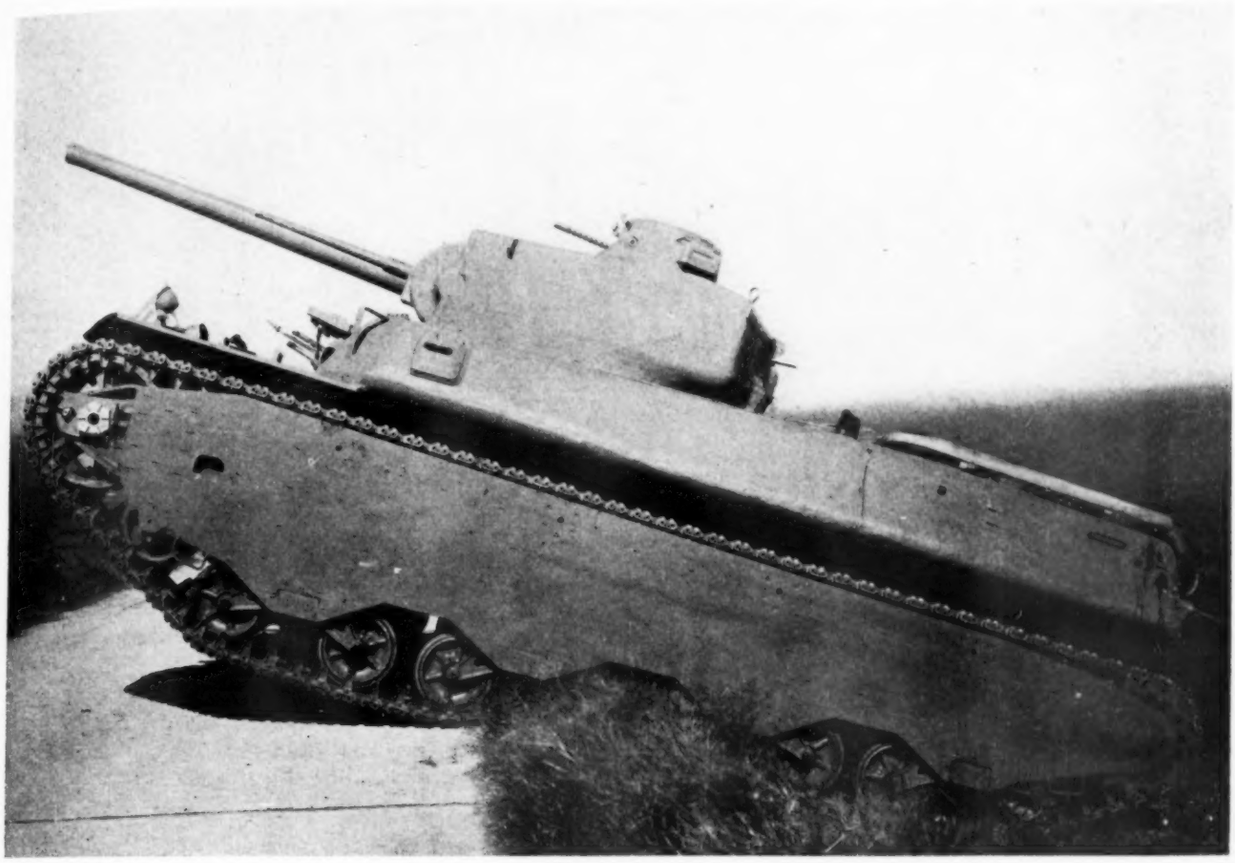
In regard to armor, it may be said that the trend of modern design is toward the use of thicker plates. Here the tank designer is confronted with a very difficult problem because, as the armor thickness is increased, the weight of the vehicle is increased, requiring greater horsepower—until the law of diminishing returns in tank design is encountered.

Mobility is likewise one of the fundamental tank characteristics in that it determines the facility with which the guns of a tank can be brought to the point of desired employment. The mobility naturally depends upon the weight of the vehicle, the power of the engine employed, the width of track, the length of the vehicle, and the corresponding pounds-per-square-inch pressure between the track and the ground. By "mobility" we mean not only speed but also manueverability under different conditions of speed and terrain. Mobility is of vital importance because it affords additional protection to the crew.

The safety of the tank personnel is dependent not only on the thickness and quality of the tank armor, but also upon the tank speed and the type of terrain over which employed. Thus, if a tank can move at a high rate of speed, it will present itself as a target to the enemy for a limited time. The length of time will determine the number of shots the enemy tank gunners can fire which will determine the number of hits which can be made. Since any armored vehicle is capable of absorbing a certain number of penetrations before it is put out of action, this time factor is of great importance. The desire of the tank designer, therefore, is always to secure the greatest possible speed over all types of terrain.

Foreign tank designers have not given speed as high a value as we have. This probably has been due to the fact that only engines of relatively lower horsepower have been available. Regardless of the reason, it is a fact that most European tanks, including German, have about one-half the horsepower-to-weight ratio of the corresponding American vehicles. For this reason, it may be expected that American tanks will travel much faster than foreign vehicles and will be more difficult to put out of action.

The power train and the running gear give the tank mobility. The units must be light because the payload on this vehicle is crew, armor, guns, and ammunition. They must be



THE ORDNANCE HEAVY TANK HAS EXCELLENT MOBILITY

readily accessible for quick adjustment, repair, or replacement, as these units have the greatest effect on mechanical reliability.

Prior to August 1940, the Ordnance Department had not undertaken the design and manufacture of a heavy tank due to lack of funds; such a project would have consumed too large a proportion of the research moneys then available. In August 1940, however, the Ordnance Department received its large appropriation from the Congress and was therefore able to afford the luxury of designing and manufacturing supertanks. It was in a position to undertake such a design since a large percentage of the tank components which had been under intensive development during the past twenty years by the Ordnance Department could be utilized in the construction of a large supertank by strengthening and enlarging these components as required for use with a large and heavy vehicle.

A NUMBER of difficult engineering problems have arisen in connection with the design of this tank. One such problem has been the development of a suitable transmission which would be able to handle the powerful engine used in the vehicle. To this end, the engineering talent of the automotive industry was called into consultation and was asked to coöperate with us. As a result, three different types of transmissions were designed and placed under manufacture. The transmission found by test to be best suited for the strenuous and exacting requirements of the heavy tank will be selected for production.

While there are heavy and supertanks in existence in Europe, there is no vehicle known to exist which would approach the American 60-ton supertank in regard to power of weapons carried and horsepower of engine used to drive it at high speeds across country. The Ordnance Department has maintained in this vehicle the same high horsepower-weight ratio employed in the designs of its light and medium tanks so that the cross-country mobility of the vehicle should in every way duplicate that of the smaller vehicles developed previously.

The two major disadvantages of a supertank are its high cost and its heavy weight with the accompanying difficulty of crossing rivers on temporary bridges. The advantages accruing to the heavy tank are its superior gun power, its heavier armor which makes it invulnerable to all but the most powerful antitank guns, and its great crushing power. In some of the important tank battles of the present war, the Germans have used supertanks mainly from the Skoda arsenal at Czechoslovakia as a spearhead of the attack.

The trend of development in tanks at the present time is continuously toward the use of more heavily armored vehicles. As previously stated, there is a distinct limit to the armor plate which can be applied to a given design of tank chassis. It becomes necessary, therefore, if the armor is to be increased materially, to design new vehicles with sufficient horsepower which have all parts proportioned to carry the heavy loads imposed by the thicker armor plate. The supertank which has just been completed by the Ordnance Department is a forerunner of a new line of heavily armored tanks and represents, it is believed, the most powerful tank which has been built in the world up to this time.

Chemistry in Warfare

Research and Development—Keys to Victory

Col. Maurice E. Barker*

OUR armed forces need most of the usual things that are in production. That means laboratory control of the purity and quality of thousands of raw materials, intermediates, and final products. This is a job for chemists on the payroll of industry and the Government. It is a big job, for every soldier has the right to expect that the food sent him will be healthful and palatable; that his shoes will be wearable and resistant to water, snow, and mustard gas; that his gun and ammunition will function in tropical storms as well as in arctic blizzards; that hospital supplies of good quality and competent medical assistance will be available when and where needed to bring him back to health when enemy bullets, service accidents, or bacteria have laid him low; that his gas mask and other equipment will serve him as required.

Not only must the supplies already standard be controlled as to quality and produced in a never-ending stream, but new things must be developed and production facilities for these new inventions must be created. We need all that science can give us in the way of new arms and equipment of many types: medicine, transportation, vitamins, and household supplies.

The chemist must do his part in finding acceptable substitutes for tin, nickel, chromium, natural rubber, brass, wool, quinine, and many other things which must be rationed and conserved to make our limited stockpiles of natural supplies meet the possible military requirements. We have set many men and women possessed of creative imagination and sound technical training to work on these problems, but all the additional help possible is welcomed.

TO the man or woman endowed with creative imagination and technical training, there is no such phrase as "It can't be done." If Jules Verne could visualize a boat that ran beneath the surface of the ocean that saw its way by means of reflecting mirrors set in a long tube coming to the surface, then competent marine engineers could build a submarine with a periscope. However, before the submarine could be constructed, some one had to visualize the need for the machine and a way in which it could be made and worked.

If "Buck Rogers" can overcome enemies of all kinds with his "ray gun," who knows how soon such weapons will be hurling their weightless bullets at human targets? Already the "atom smashers" at M.I.T., Harvard, and California Tech must have their generators buried deep in the earth and surrounded with tanks of water, shields of lead, and the approaches must be by a labyrinth of trenches constructed in the best World War style. Without these precautions, the M.I.T. "tin hat" would be a potent weapon of destruction for the entire surrounding area.

Don't think or say "This is good enough" or "This thing cannot be done." No man in responsible charge of national defense dare say or even secretly think these things since December 7, 1941. We may, and do, have to say to our production engineers, "We will make ten million items like this model," but at the same time the research department is told, "Make something better!" These better models follow so fast that manufacturers fear lest their beautiful assembly lines will be disrupted.

The following incident occurred some years ago when we of the Chemical Warfare Service Technical Staff at Edgewood Arsenal were trying to design an apparatus to spray smoke and liquid gas from an airplane in motion. We employed a famous mathematician to study the problem and advise us as to how to proceed. He made the usual assumptions to set up his differential equations and proved conclusively (to his own satisfaction) that "it could not be done," because the liquid, when thrown against the air at the then terrific speed of 80 miles an hour would break up into drops so small that they would obey Stokes' Law instead of Newton's Law of falling bodies. A pilot and I went aloft with a 10-gallon can full of red dye-water. He flipped the plane on its side, and I tipped over the can. Our mathematical friend was out to see his theorem demonstrated. As luck would have it, the blood-red water fell like a summer rain and spattered on our mathematical coworker. Was his face red?

CREATIVE, logical imagination is a mighty force in development of new processes and new things. The perfection of these things is accomplished by painstaking, methodical developmental and engineering work. National defense demands the best from all of us—from the soldier, the mechanic, the designer, the chemist, the physicist, the business man. We must have the coördinated efforts of all these people to produce new weapons and new products of all kinds which we will need desperately within the next year. We must learn a lesson from the complete coöperation shown by Hitler's tanks, artillery, infantry, and air force.

In normal years, the United States uses about half a million tons of new rubber—last year we used many times that amount. Most of our supply of new rubber is cut off now. We have some rubber in stock; we have half a dozen synthetic rubbers on the market for special purposes; we have a great stock of used rubber. It is essentially the chemist's job to make greater use of reclaimed rubber by treating it to "unvulcanize" it and to restore the molecules of the used rubber to their original state. For years we have played at this job—today we need dreamers and a flock of technicians to make new rubber from huge piles of used tires.

Neoprene, butyl rubber, Hycar, Ameripol, and other rubber-like plastics are now available in limited quantities. Each one has been so entangled in process difficulties in order to avoid patent infringement that valuable time has been lost, and the product is scarce, expensive, and not as satisfactory from a technical standpoint as natural rubber or as desirable. A pooling of the chemical and engineering knowledge and all patents on this subject has just been made that should do much to relieve the crude-rubber shortage.

We Americans have taken the tin can for granted. There must be fewer tin cans now, both to save the steel sheet and the tin coat. Other containers must be developed to replace

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An address before the student body of the College of William and Mary, Williamsburg, Va., February 4, 1942.

the ubiquitous tin can. Perhaps the ladies will have to do a bit more cooking and less can opening! Chemists, men and women, must begin an immediate, intense, and continuous search for packaging materials made from plentiful domestic sources. Why not make such containers from cotton and corn cobs? It can be done—the cotton could be formed into sheets and these bonded with plastics from the corn cob or from the protein residue left from corn during its processing into sirup (*e.g.*, zein plastic).

What a challenge quinine is to organic chemists! Are they going to sit placidly by and watch our own malaria-bearing mosquitoes wage a terrible bacteriological warfare for the Japs? We need several million ounces of quinine yearly. Most of this comes from the plantations of the East Indies.

Who knows what may be accomplished by the proper heat, sound, X-ray, or physical treatment of iron alloyed with such cheap and plentiful domestic raw materials as silicon, carbon, and titanium? We must have huge quantities of corrosion-resistant metals for chemical-plant equipment. Perhaps the gold and silver in our vaults might well be put to work as a lining for reaction kettles and stills. What a joy a gold-lined reactor would be to the man who prays each day that his precious thousand-gallon glass-lined reactor will not crack! And why not? The gold would not be used up—it would be doing its bit for national defense. Therefore, I say, let's take out a few tons of gold and a few hundred tons of silver from the vaults and use them to overcome some of our serious corrosion problems which are bound to get worse due to the growing scarcity of monel and stainless steel. Then, too, other solutions to the corrosion problem might be found.

We do not have enough sheep to furnish all the wool we need; but there are rayon, nylon, and cotton. If cotton could be converted into a fiber having the desirable effects of wool, what a boon this would be to the cotton farmer, the cotton-mill owner, and the worker. Here is a problem that every southern chemist should take to heart. Who knows that a process cannot be worked out that will make cotton the king of all fibers? We know now that it can be made water resistant and almost fireproof.

We have made a good start on the vitamin problem. At least we know that vitamins are useful and can be produced. A plentiful supply is essential for our national health and well-being. Improvements are in order.

A few years ago, synthetic toluene was a dream. Now, thousands of gallons are pouring from our factories every day. The job has just started, for without toluene there will be no TNT. There is plenty of room for progress and improvement in this field.

Five years ago butadiene was a rare chemical. Next year we will make thousands of tons. That will be a fair beginning, but a beginning only. Starting materials may be natural gases or buttermilk. Here is a great field for the organic chemist and the chemical engineer. Synthetic rubber is here to stay. For this we must have butadiene in great quantity and at a low price. The same applies to styrene and acrylo nitrile.

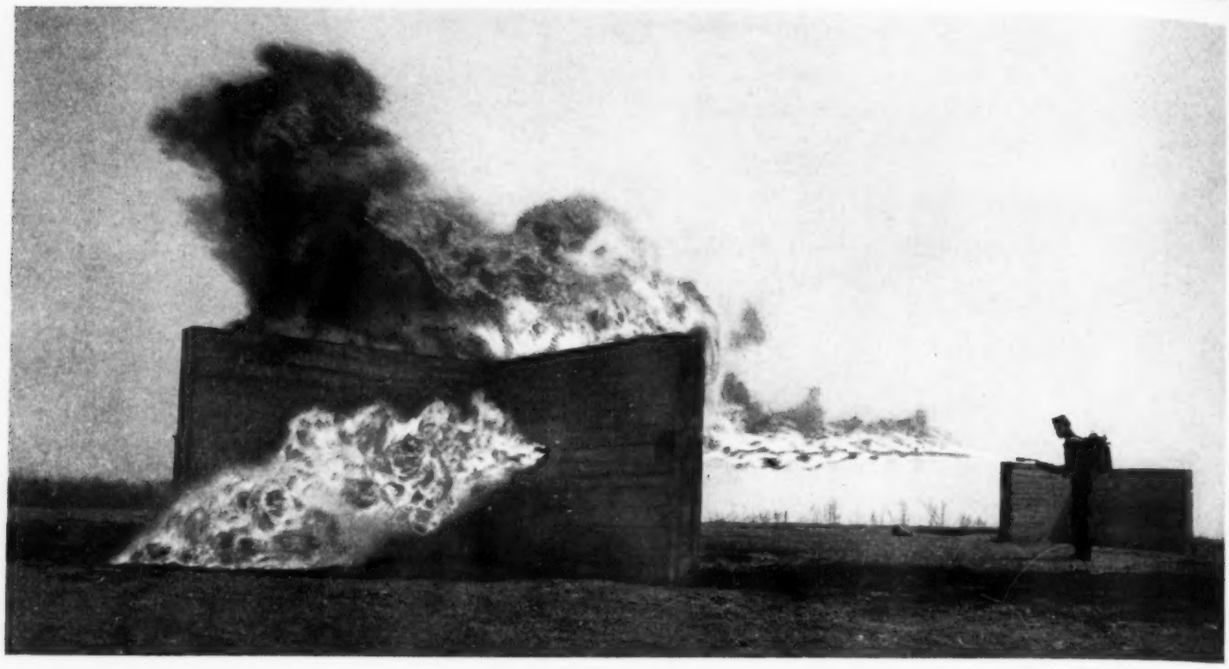
Hall discovered the basic principles of producing aluminum from bauxite by electrolysis while he was still an undergraduate. We have comparatively little bauxite in the United States. Other proven supplies available to us are not inexhaustible, but there is plenty of aluminum in clay which is scattered over the entire United States. The aluminum is there—we need it. It can be extracted, for a pilot plant has been operating on domestic clay for a year. The perfection of this process will be a real contribution to national defense and to America—aluminum is needed for airplanes, for making thermit fillings for incendiary bombs, and for many other uses, both military and civil.

We need a lot of better things, such as a good 10-cent dust mask; waterproof, air-permeable, unwettable fabrics of many kinds for tents, gloves, clothes; fire-resistant cloth for use of guards in munition works, workmen in powder and incendiary plants, and soldiers in tanks and airplanes; better smoke filters for air-purifying devices; new synthetic fibers having a diameter of a micron or less; and others.

LARGE numbers of research chemists and chemical engineers are employed by the National Defense Research Committee (N.D.R.C.) in our college, university, and industrial laboratories on problems proposed by the supply services of the armed forces. The Air Corps, the Ordnance Department, the Naval Research Laboratory, and the Chemical Warfare Service employ large numbers of chemists of all kinds, chemical engineers, and other scientists, on problems of direct military application. Never before in our nation's history has such a vast coördinated research and development program been undertaken.

When any of the armed services has or foresees the possible need for specific scientific information not available in the literature, the problem is described, the kind of information needed is outlined, and the N.D.R.C. is requested to investigate the problem. This committee places a contract with one or more educational or industrial laboratories and the problem gets under way at once and is directed by the best available men who employ the assistants required. The information obtained is furnished the armed services by means of reports and personal conferences. Direct application of the information to military problems is then initiated by the supply branch concerned, and N.D.R.C. and industrial specialists are brought in to assist from a scientific and practical manufacturing viewpoint.

Gas masks, new manufacturing methods, new guns, new tanks, new airplanes, and other needed military weapons and supplies are then designed and produced in limited quantities. Part of these are put into the hands of troops for field tests. Others are submitted to synthetic tropical conditions, cold tests, rough handling, infra-red and ultra-violet exposure, and to every form of mechanical and chemical torture that can be thought of as possibly affecting the functioning of the article. As a result of the information obtained from these field, laboratory, and engineering tests, improved models are produced until we get a process or model that performs satisfactorily and is suitable for quantity production. Both performance and procurability must be considered and achieved. This is a long, tedious, expensive process, but untested equipment must not be sent into battle. Of course, we should have done all this during the years of peace, but money, men, and driving incentive were not available. Today, no effort or cost is being spared to develop these new weapons and items of supplies. But this sort of thing cannot be done in a day or a week or a month. We are driving ahead as fast as human nerves and sinews can hold together. Many of our men have put in sixty and seventy hours of intense labor every week for months. They will do their best without regard to damage to their health, or lack of safety, or earned vacations, or other personal sacrifice. Victory must be won at all costs.



Chemical Defense

Characteristics of the Principal Military Weapons

Lieut. Col. Alden W. Waitt*

FOR each situation in which a chemical weapon can be used, some one must answer the question, "What is the proper weapon?" The answer depends upon how much chemical agent must be placed on the target, the distance to the target, how quickly the chemical must be put down, and how much time is available before it must be put down.

If a special weapon is designed for the purpose of dispersing a chemical agent, it is obvious that there must be a requirement for it not met by any existing weapon. Not many of the weapons used for firing explosives are suitable for projecting chemicals. An efficient chemical weapon should have mobility, ease of handling and movement from place to place, rapidity of fire, high capacity for chemical contents, and sufficient range (the mass of chemical fire is generally at short or intermediate ranges). Cheapness and ease of procurement and high angle of fire are desirable.

Certain chemicals, notably the nonpersistent agents which dissipate rapidly, such as phosgene, must be placed on the target in maximum quantities in a minimum of time. This means high shell capacity and rapid rate of fire. The long-range weapons designed for high explosives are necessarily deficient in this respect. For example, the 75-mm. gun was not designed to fire a high-capacity shell at a rapid rate. The 75-mm. shell is thick-walled and holds little chemical. It is entirely unsuitable for firing a nonpersistent agent. It is, on the other hand, one of the best weapons for firing mustard gas, which, because of its high persistency, can be placed on the target over a long period of time.

In order to meet the need for a weapon which will place on a target a large amount of chemical in a short time, three special weapons have been developed for use by chemical troops. They are the portable cylinder, the Livens projector, and the 4.2-inch chemical mortar. These weapons have been standard for years, and most of the readers of ARMY ORDNANCE are better acquainted with them than with many of the other weapons for disseminating chemicals.

The portable cylinder is 18 inches high and 8½ inches in diameter. It is loaded with about 30 pounds of gas and weighs 48 pounds when filled. Operation is controlled by a valve which can be opened by hand or by an electrical firing attachment. The compressed gas is forced out under its own pressure to vaporize and form a gas cloud. Although dependence on wind direction and weather limit its use, the gas cylinder still has much importance as a weapon of opportunity.

The Livens projector is a smoothbore mortar, embedded in the ground, which fires one shot per installation. Projectors usually are installed in batteries of twenty-five fired simultaneously by electricity. A projector attack amounts to hurling a number of gas cylinders at the enemy, so that the cloud is started in the hostile lines rather than in friendly territory. The range of the weapon is about 1,450 yards. Each shell carries twenty-eight pounds of phosgene or similar gas. It is a simple and effective weapon, but installation requires much labor and it rarely can be used unless conditions have stabilized temporarily.

The 4.2-inch chemical mortar is a muzzle-loading, rifled, high-angle weapon which fires a high-capacity shell with the accuracy of an artillery piece at ranges from 600 to 2,400 yards. It can deliver five rounds per minute for sustained fire and twenty rounds per minute for short periods. It is

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This article will appear as a chapter of a book by Colonel Waitt on chemical warfare to be published shortly.

mobile, low in silhouette, can be easily concealed, and can be fired from small gulches, shell holes or from behind steep ridges. Within its range it is a particularly suitable weapon for support of attacking troops either with smoke, gas, or explosive. It is the standard weapon of chemical troops.

THE peculiar characteristic of mustard-type agents make them especially valuable for rendering ground unusable. If it is desired to prevent or deter an enemy from occupying or crossing a piece of ground, all that is necessary is to contaminate it liberally with mustard gas. Concentrations of a persistent casualty agent either will prevent occupation of this area or will assess a heavy penalty in casualties or labor on the force which occupies it. This is an entirely new conception in war which chemicals have brought about.

Where the place to be contaminated is in enemy territory, shells or bombs are fired upon it. Sometimes, however, in defensive situations or in a withdrawal it is desirable to contaminate ground now in the possession of friendly troops but over which an enemy force must advance to reach the defender. Likely avenues of approach on the flanks of a defensive position, creek bottoms, dry runs, valleys up which the enemy might come, all offer suitable areas on which to place mustard gas.

Mustard-type agents may be applied directly to an area in a number of different ways. The British Gas Defense Regulations mention contamination by means of hand contamination bombs, vehicles specially fitted for spraying vesicant agents, large containers fired by time fuses, and contact or delayed-action mines. In his text, "Military Chemistry," Y. M. Fishman, erstwhile chief of the Military Chemical Administration of the Red Army, describes hand chemical grenades, chemical mines, and special ground appliances for the infection of an area. The latter he considers the simplest means for what he calls "infection ahead of time." These ground appliances may be carried by one man (so-called kit type) or placed on a cart or motor vehicle. The principle of action is the same for portable and vehicle appliances and consists of spraying the agent from the container by compressed air or by special pumps operated by hand or motor. The Italian regulations describe similar devices for what they term soil contamination. These seem rather complicated and dangerous. If mustard is to be sprayed, it is best to be a safe distance away. Certainly pumping mustard by hand from a portable sprayer would be anything but healthy.

A much simpler and safer method was described in a French study on war gases, published in 1925 by the Artillery School of Application, which states that, in addition to the gassing of terrain by fire with mustard-gas shell, "devices can be used consisting of cylinders containing mustard gas which are shattered at the right time by the explosion of a small charge." Major Kleeberg of the German Army, in an article in the *Militar-Wochenblatt,* several years ago also advocated a similar means—the use of static gas mines (*Gasbuchsen*) to create obstacles.

The most satisfactory device for the purpose of exploding mustard gas is the chemical land mine, which consists of a container made of metal, glass or other material loaded with persistent gas and provided with an explosive charge to burst the container and release the chemical. These land mines are emplaced by hand in the area in which they are to be used. They may be exploded individually by time fuse or connected together for electrical discharge in large numbers at one time.

Mines can be used in large numbers to contaminate roads or to establish gas barriers. They are especially applicable in defense and delaying action, either alone or with demolitions and other obstacles.

In laying gas mines to contaminate areas in order to deter occupation or passage or to contaminate demolitions so that the damage cannot be repaired without contact with the agent, the mines are placed close enough to each other to obtain an overlap of gassed area resulting from the bursts, and to produce a heavy enough concentration. With large areas, fewer mines are required per hundred square feet than on small and narrow targets. Such areas can be contaminated satisfactorily by placing mines about twenty-five yards apart, preferably in a hit-or-miss pattern.

SMOKE produced by the detonation of a bomb or shell sometimes forms an inefficient screen because the force of explosion causes a large part of the smoke to be blown high into the air. The ideal smoke screen is one that resembles a fog, hangs well to the ground, and does not dissipate rapidly. To meet these requirements, as well as to provide a munition that could be carried easily and used under many different battlefield conditions, a demand arose for a small compact munition which could be carried and set off by an individual. The smoke candle was the result of this demand. It found wide use in trench warfare, and when used properly under favorable conditions it is still an efficient weapon. Smoke candles or smoke grenades may be used to screen movements within friendly areas, to screen river crossings, to disguise or simulate cloud attacks with cylinders, or to draw enemy fire to unimportant places. Small forces frequently are able to use candles effectively in withdrawing from action.

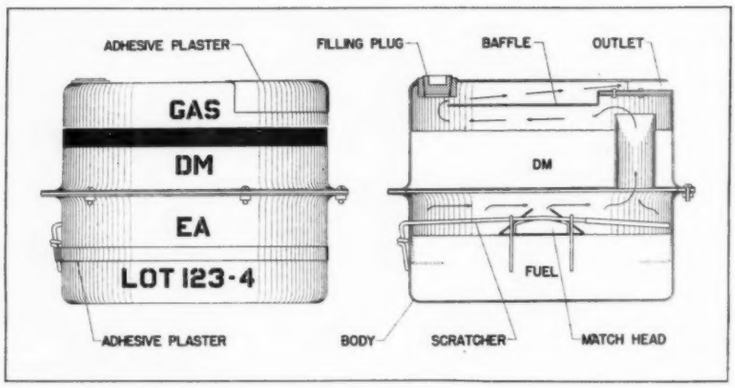
There has been developed for training a device called the smoke pot. This is a tin can not quite 7¾ inches high and a little over 5¼ inches in diameter which contains HC smoke mixture, a fast-burning starter, and an ignition device of match-head composition. A scratcher block with the same material on it that is used on the side of a match box is provided to light the match head. The match head starts the fast-burning compound which ignites the HC smoke mixture. The smoke reaches maximum production in about 20 seconds, and the smoke pot continues to burn for some 6½ minutes.

When the Germans introduced sneeze gas (DA) in July 1917, they fired it in artillery shells which they marked with a blue cross. A bottle of the DA was embedded in high explosive within the shell. These "Blue Cross" shells dispersed the DA by explosion. The particles of sneeze gas that were produced by the explosion were relatively large and were easily removed from the air by filters which soon were placed in all gas masks. At about the close of the war it was learned by our chemical-warfare experts that if the irritant agent were heated or if hot gases from burning powder were passed across it the sneeze gas would be vaporized and would pass into the air as an extremely fine cloud of particles which would penetrate filters of any but the very best gas masks. Moreover, in this finely divided state the agent had a much more powerful effect on the body.

As a result of their research, the irritant smoke candle was developed. It is a very effective weapon when it can be used properly, but, like the gas cylinder, its use is dependent on wind and weather. As it is fired statically, in or close to friendly lines, the concentration of gas is greatest where it is least desired. The irritant candle consists of two cans each

seven inches in diameter and not quite three inches high bolted together one above the other with an asbestos gasket between (see illustration on this page). The bottom can contains a cake of smokeless powder fitted with a wire ignition device which permits drawing a scratcher of matchbox composition over a match head in the center of the powder. A small circular flue is the only opening between the bottom and top compartments.

The top can contains a 2-pound cake of DM (diphenylamine chlorarsine—a sneeze gas). The heated gases from the burning powder in the lower can have to pass closely over the surface of the cake of DM before they can get out into air. The smoke leaves the candle through a slot in the wall of the upper can which is normally covered by a piece of adhesive tape to keep out dirt and moisture (see illustration on next page). The can is operated by taking off the tape and moving the wire ignition device back and forward rapidly until the matchhead material is ignited by contact with the scratcher. The candle burns three or four minutes and produces a heavy canary yellow cloud with a smoky odor which is extremely irritating. The effects of DM have already been described. The smoke is so fine that it will pass through the ordinary gas-mask filter, although the Army gas mask will remove it. This weapon has never been used in war. If used it would be necessary to fire large numbers under favorable wind and weather conditions. It is a very effective weapon in civil disturbances, especially against mobs equipped with protection against tear gas.



Outside and Section of DM Irritant Gas Candle

THE exact time grenades were first used in war is uncertain, but they are known to date back many centuries. Up to the close of the eighteenth century, soldiers were regularly trained in throwing hand grenades and were called grenadiers. Then for a century they went out of fashion. Their use was again revived by both sides in the Russo-Japanese War. In the last World War, the grenade was a regular part of the equipment of all infantry soldiers.

Both high-explosive and chemical grenades are useful in the attack and in the defense. They are especially useful in clearing out bombproofs and dugouts. Because of the high-angle fire of both the hand and rifle grenades they may be used in the trenches when no target for riflemen can be seen. When artillery and mortar fire can no longer be used because of the nearness of the fighting lines, grenades may be used to great advantage. This applies equally well to both offensive and defensive operations.

Grenades containing smoke and incendiaries are especially useful for small screening operations and also for casualty effect on personnel in small centers of resistance such as machine-gun nests. Chemical grenades have found wide use in war, in peace-time training, and in civil disturbances. During the World War, the phosphorus rifle grenade was an extremely valuable and effective weapon.

Chemical hand grenades may be thrown or may be placed on the ground where they operate as a small candle. All the standard chemical grenades at present are of the burning type. They can be thrown by hand a maximum distance of thirty-five yards, but the average soldier probably attains a distance nearer twenty-five yards. These munitions may be dropped from fast-moving vehicles such as armored cars or tanks either by hand or by a simple dropping mechanism.

The chemical grenade is a tin cylinder 2⅜ inches in diameter and 4½ inches high. It is constructed and operated much the same way as the candle. Small holes are punched in the side and top through which the smoke and gases can escape. When not in use, the holes are sealed by small squares of adhesive tape. The burning mixture which produces the smoke or the irritant cloud is ignited by a fast-burning mixture which in turn is started by an ignition device. The ignition device represents practically the only difference between the candle and grenade. In the grenade, a standard fuze is used for ignition. The flash from the primer ignites the powder train in the fuze. The fuze burns two seconds before igniting the starter which in turn ignites the burning mixture, and the gas is generated. The pressure from the burning material forces the little squares of adhesive tape from the holes and the gases escape through them.

The usual mixtures in the chemical grenades are either tear gas and smokeless powder in the CN grenade, or a mixture of tear gas and adamsite (DM) and smokeless powder in the CN-DM grenade. The smokeless powder provides the heat which vaporizes the chemical agent and gets it into the air. There is also a smoke grenade. This is really a small smoke candle with a grenade firing mechanism, but it has been officially designated a grenade by the Army. It is the same in design as the chemical grenade except that holes are punched in the top and not the side of the can.

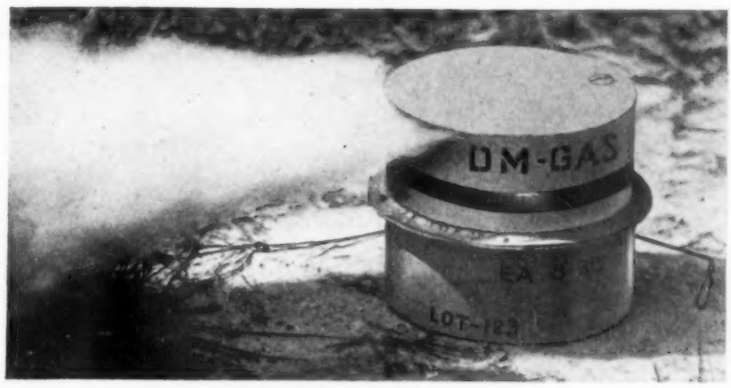
Chemical grenades are timed to ignite in two seconds, since their major use is in riots and in other civil disturbances. Earlier types had 5-second time fuzes, but it was found that the troublemakers at whom they were thrown could pick them up before they had gotten well started and throw them back at the peace officers.

There are a great many different types of chemical grenades manufactured by civilian concerns. Some of these are fired from gas guns. Many of them are equipped with some means of preventing rioters from picking them up and throwing them back. One munition, called the "jumper repeater," used by police departments, is a grenade which has a small charge of explosive in it and is so designed that after two or three seconds it will jump into the air and fly to another position a few yards away. It jumps two or three times, and by the time it has stopped jumping it is producing its gas in such volume that it cannot be safely picked up.

A crude type of grenade, but one which proved very ef-

fective during the Spanish Civil War, the Russo-Finnish War, and which is being used successfully in the present war, is the "Molotov cocktail." This is simply one or more bottles filled with gasoline, kerosene, and sometimes tarry material and wrapped with cotton waste. The idea is to throw them against the sides and tops of tanks or other armored vehicles. An ignition device may be combined with the bottle and the waste so that the contents burn as the bottle breaks, or the inflammable liquids may be lighted by throwing an incendiary grenade against a vehicle that already has been covered with combustible material. All that is necessary is to break a bottle of gasoline against the metal sides or top of the tank and then set fire to the gasoline.

There are many combinations of this idea which can be improvised by soldiers or partisans from whatever they have at hand. Tar is added so that the liquid will not run off the sides of the tank quickly. When more elaborate means are not available, the man throwing the "cocktail" generally lights the gasoline-saturated cotton waste surrounding the bottle before he throws it. The "Molotov cocktail" is perfectly adapted to guerrilla fighting. It has found wide use against tanks moving through cities or heavily wooded country. A box of a dozen or two dropped on a tank from a second-story window is guaranteed to bring the crew out of the tank in record time. To be really effective, it should be used in fairly large numbers and against both sides and top of a vehicle.



THE DM IRRITANT GAS CANDLE IN OPERATION

ARTILLERY and antitank guns are the most dangerous enemies the tank has to cope with on the ground. Successful operation of tanks requires that these guns and their ground observation posts be blinded by well-placed smoke. The value of smoke screens in assisting tanks to accomplish their mission has been amply demonstrated in action. British officers of tank units insist that smoke is an absolute necessity for tank operations, that tanks must be equipped with some device for laying smoke themselves, and also that they should have special smoke units to support them.

There are a number of different devices at present in use for producing smoke from tanks. The simplest is the exhaust smoke producer. This is a simple apparatus which permits the driver to inject crude oil or chemical into the exhaust manifold of the vehicle which may be a tank, truck, automobile, or even a motorcycle. The great heat in the exhaust manifold vaporizes the smoke material, and it pours from the exhaust in a heavy cloud. The purpose is to produce a large puff of smoke behind which the vehicle may gain protection for a few moments if it suddenly runs into antitank gunfire or otherwise gets into trouble. It is not a cure-all, and ordinarily would not be used for laying a continuous screen, since by doing this it might merely outline its own path for the hostile gunner. However, if a vehicle is proceeding along a road and meets hostile resistance, it can turn quickly, eject its smoke in two or three large puffs, and get away or decide what further action to take. Tear gas may be added to the smoke without difficulty.

Bootleggers made use of a device such as this in the prohibition era. They used it to eject smoke behind them as they tried to outrun the "revenuers" or the police. The police car, running into the smoke, had to reduce its speed and creep along. The bootlegger car could continue at full speed and, according to news reports, a great many of them escaped by this method along the Washington-Baltimore-Philadelphia highway where it seems to have found its greatest use.

Another device which has wider application is a small smoke mortar or grenade thrower. With a weapon of this sort the smoke is thrown a few hundred yards away from the tank in the direction of the source of danger. Thus there is no chance of the smoke itself becoming an aiming point as is the case when the exhaust-type smoke is improperly used. At least two different smoke mortars of this nature have been used in the present war. One is a muzzle-loading device fastened to the outside of a tank which throws a smoke grenade a distance of two or three hundred yards. It has a disadvantage in that to fire it a man has to reach outside the tank and drop the smoke grenade or cartridge down the muzzle. It is projected by a shotgun cartridge, but further details of this weapon are lacking.

The other is a breech-loading, 2-inch mortar which fires a small smoke munition for distances up to seven or eight hundred yards. It may be fired from inside the vehicle, the muzzle being pointed out through a port. It has proved very satisfactory. Some such weapon is important for emergency use by armored vehicles. Large smoke screens cannot be produced by any small-caliber mortar but sufficient smoke is developed for "get-away" purposes. It is surprising how small a haze will prevent accurate fire. Thick smoke not only is unnecessary but may be undesirable. Frequently, tanks or reconnaissance vehicles run into unexpected opposition. Antitank gun fire suddenly may halt them and cause a change in plan. In such a case there should be some way to place smoke between the vehicle and the source of trouble. All that is needed is enough cloud to prevent aimed fire on the vehicle for one or two minutes. During this time the commander can make up his mind whether he should go ahead or, if the opposition is too heavy, withdraw. The tank is especially vulnerable at the moment of turning and moving to the rear. Such "get-away" smoke provided by the small mortar is at times vital.

In addition to the small weapon, a proportion of the tanks may carry a larger-caliber mortar for laying large smoke screens. A tank mortar which proved to be most successful in Europe during the German drive through France was a weapon of slightly larger caliber than the 4-inch mortar, with a range of better than 2,000 yards. Experience has

WHITE PHOSPHORUS LAND MINE

shown that a certain proportion of the tanks in a unit, say one out of every four or five, should have this large-caliber smoke mortar, or armored regiments should have attached for their support chemical-mortar platoons in track-laying vehicles ready at all times to lay down fairly large screens at ranges up to the limit of the mortars.

THE Chemical Warfare Service years ago developed a simple method of dropping smoke grenades through a tube which projected from the back of a truck. The grenades were armed and then pushed through the tube while the vehicle was in motion. While in the tube the firing lever was depressed, but upon dropping out a spring threw off the lever and fired the grenade. This method still offers promise. Foreign writings, especially Russian and Italian, have described means of contaminating ground with mustard gas from moving vehicles. These devices include mine layers and mustard-gas spray tanks in which the pressure is supplied by hand pump or motor-driven pump. In the former case, mustard gas mines with time fuzes are dropped from the rear of the vehicle automatically or by hand.

If chemical warfare begins again it is quite likely that vehicles of armored forces will be used to disperse chemical agents. Their ability to move fast and cover long distances will make it possible for a commander to contaminate areas on a flank or in any dangerous direction over which he expects an enemy to proceed. Not much thought has been given to the use of a tank as an agent for distributing gas, but the possibilities are great.

The Infantry has adopted the 81-mm. mortar as its mobile high-angle-fire weapon. It is similar to the old Stokes mortar but has much greater range and increased mobility and is easier to install. True flight is obtained by streamlining the shells and providing them with stabilizing fins. Operation is similar to the Stokes. The 81-mm. mortar is not suitable for firing gas since the shells will not hold enough chemical agent. It is essentially a weapon for firing high explosives against personnel and light matériel targets. It does carry a standard smoke shell, however, and could be used for firing incendiaries. It is not practicable to lay a large smoke screen with the 81-mm. mortar, but it is useful to blind small, well-defined targets. Individual rounds of smoke are used to designate targets or to identify the fire of a particular mortar so that the target can be neutralized or eliminated by the fire of heavier weapons or that of the mortar itself.

The 81-mm. weapons in an organization are normally too dispersed for large screens. There are two in each heavy-weapons company of our Infantry battalion. The range with the smoke shell, which weighs 11½ pounds and holds 4 pounds of WP, is not quite 2,500 yards. The rate of fire is very rapid, a maximum rate of 30 rounds a minute being claimed for trained crews.

The Army has recently developed a portable flame thrower for use by chemical troops and engineer troops which can be carried easily by one man (see illustration on page 740). The flame is effective for a distance of about thirty-five yards. A larger flame thrower has been developed for use on tanks. This one has a range of nearly eighty to one hundred yards. It is probably not practical to build flame throwers with ranges over a hundred yards because of the size of the machine. Range depends on the distance that the oil can be thrown before it is broken up into a fine spray or consumed by burning.

The portable flame thrower seems to have found a place in a carefully organized attack on a strongly fortified position. For clearing dugouts, trenches, emplacements, or any confined spaces it is a useful and time-saving weapon. Against tanks it presents very interesting possibilities if some means can be found of getting the machine within range of the tank to be attacked. There is no question concerning the power of the tongue of flame if it can be brought close enough to the target—the difficulty is bringing the two together. On the offensive, a strong shield must permit the man or the flame-throwing machine to get near enough to the defender to dislodge him. This shield may be fire power or armor, but whether it is bullets or armor plate it must be present. Otherwise the defender is going to stop the flame thrower by his own fire before it can approach close enough to be effective. On the defensive, it may be useful for the close-in defense of important points. Here again it must be heavily armored lest enemy explosives strike it and spill the inflammable oils where they will burn up that which they were intended to defend.

I feel safe in saying that the flame thrower will never be as decisive a weapon as its early predecessor, Greek fire, was reported to be. Its greatest value is as a morale destroyer—it looks much worse than it really is. It is calculated to terrify and doubtless will terrify the poorly trained man.

However, as in all phases of warfare, training is a weapon in itself, and the trained force is usually victorious.

PROTECTION AGAINST

General Information Concerning the Characteristics, Effects, and C

CLASS	NAMES AND SYMBOLS	FORM	ODOR	PHYSIOLOGICAL EFFECT	TACTICAL CLASS	PROTECT
VESICANTS	MUSTARD $S(CH_2CH_2)_2Cl_2$ Dichlorethyl Sulphide	Liquid and Vapor	Garlic, Horse-radish, Mustard	Delayed effect. Burns skin or membrane. Inflammation of respiratory tract leading to pneumonia. Eye irritation, conjunctivitis.	Hospital case.	Gas ma and ful protecti clothin
VESICANTS	LEWISITE $CHClCH\text{-}AsCl_2$ Chlorvinyl-Dichlorarsine	Liquid and Vapor	Geraniums	Burning or irritation of eyes, nasal passages, respiratory tract, skin. Arsenical poison.	Hospital case.	Gas ma and fu protecti clothin
VESICANTS	ETHYLDICHLORARSINE $C_2H_5\text{-}AsCl_2$	Liquid and Vapor or Gas	Stinging, like pepper in nose.	Causes blisters, sores, paralysis of hands, vomiting. Severe on long exposure.	Hospital case.	Gas ma and fu protecti clothin
LUNG IRRITANTS	CHLORINE Cl_2	Gas	Highly pungent	Lung irritant.	Hospital case.	Gas ma
LUNG IRRITANTS	CHLORPICRIN CCl_3NO_2 Nitrochloroform	Gas	Flypaper, anise	Causes severe coughing, crying, vomiting.	First-aid treatment and hospital case.	Gas ma
LUNG IRRITANTS	DIPHOSGENE $ClCOOC\text{-}Cl_3$ Trichlormethyl Chloroformate	Gas	Ensilage, acrid	Causes coughing. Breathing hurts, eyes water, toxic.	Hospital case.	Gas ma
LUNG IRRITANTS	PHOSGENE $COCl_2$ Carbonyl Chloride	Gas	Musty hay, Green corn	Irritation of lungs, occasional vomiting, tears in eyes, doped feeling. Occasionally symptoms delayed; later, collapse, heart failure.	Hospital case.	Gas ma
LACRIMATORS	CLORACETOPHENONE $C_6H_5CO\text{-}CH_2Cl$	Gas	Apple blossoms	Makes eyes smart. Shut tightly. Tears flow. Temporary.	First-aid treatment.	Gas ma
LACRIMATORS	BROMBENZYLCYANIDE $C_6H_5CH\text{-}BrCN$	Gas	Sour fruit	Eyes smart, shut, tears flow. Effect lasts some time. Headache.	First-aid treatment.	Gas ma
STERNUTATORS	ADAMSITE $(C_2H_4)_2\text{-}NHAsCl$ Diphenylaminechlorarsine	Gas	Coal smoke	Causes sneezing, sick depressed feeling, headache.	First-aid treatment.	Gas m
STERNUTATORS	DIPHENYLCHLORARSINE $(C_6H_5)_2\text{-}AsCl$	Smoke	Shoe polish	Causes sick feeling and headache.	First-aid treatment.	Gas m
SMOKES	HC MIXTURE $ZN : C_2Cl_6$	Smoke	Sharp-acrid	Harmless.	Smoke.	None n
SMOKES	SULPHUR TRIOXIDE $SO_3 : SO_3HCl$ In Chlorsulfonic Acid	Smoke	Burning matches	Causes prickling of skin, flow of tears.	Smoke.	Gas m
SMOKES	TITANIUMTETRACHLORIDE $TiCl_4$	Smoke	Acrid	Harmless.	Smoke.	None ne
INCENDIARIES	WHITE PHOSPHORUS P	Smoke	Burning matches	Burning pieces adhere to skin, clothing.	Incendiary smoke. First-aid treatment.	None ne
INCENDIARIES	THERMIT $8Al : 3FeO_4$	Incendiary	None	5,000-degree heat ignites materials.	Incendiary.	None ne

Prepared by Lieut. Col. Walter P. Burn, C.W.S.

PROTECTION AGAINST WAR CHEMICALS

ning the Characteristics, Effects, and Counteraction of the Agents an En

LOGICAL EFFECT	TACTICAL CLASS	PROTECTION	FIRST AID (After removal from gassed area)
fect. Burns skin or e. Inflammation of y tract leading to a. Eye irritation, itis.	Hospital case.	Gas mask and full protective clothing.	Undress; remove liquid mustard with protective ointment, bleach paste, or kerosene; bathe; wash eyes and nose with soda solution.
r irritation of eyes, sages, respiratory t. Arsenical poison.	Hospital case.	Gas mask and full protective clothing.	Undress; remove liquid Lewisite with hydrogen peroxide, lye in glycerine, or kerosene; bathe; wash eyes and nose with soda. Rest—Doctor.
sters, sores, paraly-ls, vomiting. Severe posure.	Hospital case.	Gas mask and full protective clothing.	Undress; remove liquid with hydrogen peroxide, lye in glycerine, or kerosene; bathe; wash eyes and nose with soda. Rest—Doctor.
ing irritant.	Hospital case.	Gas mask.	Remove from gassed area. Keep quiet and warm. Coffee as stimulant.
vere coughing, crying.	First-aid treatment and hospital case.	Gas mask.	Wash eyes, keep quiet and warm. Do not use bandages.
ughing. Breathing s water, toxic.	Hospital case.	Gas mask.	Keep quiet and warm. Give coffee as a stimulant.
of lungs, occasional tears in eyes, doped Occasionally symp-yed; later, collapse, re.	Hospital case.	Gas mask.	Keep quiet and warm; rest in bed. Coffee as a stimulant. Loosen clothing. No alcohol or cigarettes.
es smart. Shut Tears flow. Tem-	First-aid treatment.	Gas mask.	Wash eyes with cold water or boric-acid solution. Do not bandage. Face wind. For skin, sodium sulphite solution.
t, shut, tears flow. s some time. Head-	First-aid treatment.	Gas mask.	Wash eyes with boric acid. Do not bandage.
neezing, sick de-eling, headache.	First-aid treatment.	Gas mask.	Keep quiet and warm. Loosen clothing. Reassure. Spray nose with neo-synephrin or sniff bleaching powder. Aspirin for headache.
k feeling and head-	First-aid treatment.	Gas mask.	Remove to pure air, keep quiet. Sniff chlorine from bleaching-powder bottle.
Harmless.	Smoke.	None needed.	Produces no effect requiring treatment.
ickling of skin, flow	Smoke.	Gas mask.	Wash with soda solution.
Harmless.	Smoke.	None needed.	Produces no effect requiring treatment.
ieces adhere to skin,	Incendiary smoke. First-aid treatment.	None needed.	Pack in cloths wet with copper sulphate (blue vitriol) or water or immerse in water. Pick or squeeze out particles. Treat for burn.
ee heat ignites ma-	Incendiary.	None needed.	Treat for severe burn.

LS

nts an Enemy Might Use in War

ssed area]	PERSISTENCE	FIELD NEUTRALIZATION	GENERAL INSTRUCTIONS
l mustard nt, bleach the; wash oda solu-	One day to one week; longer if dry or cold.	Cover with unslaked lime and earth; 3% solution of Na_2SO_3.	The importance of proper first aid for gas victims cannot be overemphasized. The following are general rules which apply in all cases. A. Act promptly and quietly; be calm. B. Put a gas mask on the patient if gas is still present or, if he has a mask on, check to see that his is properly adjusted. If a mask is not available, wet a handkerchief or other cloth and have him breathe through it. C. Keep the patient at absolute rest; loosen clothing to facilitate breathing. D. Remove the patient to a gas-free place as soon as possible. E. Summon medical aid promptly; if possible, send the victim to a hospital. F. Do not permit the patient to smoke, as this causes coughing and, hence, exertion.
l Lewisite de, lye in e; bathe; ith soda.	One day to one week; longer if dry or cold.	Wash down with water. Cover with earth. Alcohol. NaOH spray.	
uid with in glyc- he; wash a. Rest—	One hour.	Cover with earth, caustic.	
ea. Keep e as stim-	10 minutes.	Alkaline solution.	
nd warm.	Open 6 hours; woods 12 hours.	$NaSO_3$ Sodium sulphite in alcohol solution.	
n. Give	30 minutes.	Alkali.	
; rest in imulant. lcohol or	10 to 30 minutes.	Alkali.	
water or Do not For skin, on.	10 minutes.	Strong, hot solution of sodium carbonate.	
acid. Do	Several days (weeks in winter).	Alcoholic sodium hydroxide spray.	
Loosen pray nose or sniff pirin for	10 minutes.	Bleaching powder solution.	
ep quiet. leaching-	Summer 10 minutes.	Bleaching powder solution.	
requiring	While burning.	None needed.	
n.	5 to 10 minutes.	Alkaline solution.	
requiring	10 minutes.	None needed.	
opper sul- ter or im- r squeeze burn.	10 minutes.	Burns out.	
	5 minutes.	Quickly cover with earth or sand.	

New Field Weapons

Two new field artillery weapons recently have been standardized. The improved 155-mm. howitzer, shown above in travel position, will eventually replace the French-type Schneider 155-mm. howitzer now in use. The 4.5-inch gun, shown below in travel position, is suitable for corps artillery and antitank missions. The same type carriage is used for gun and howitzer.

Must Sea Power Win?

Navies, Unaided by Armies, Are Not Omnipotent

Hoffman Nickerson*

WE are land animals. All voyages start from the land, and all successful ones return to it. Since more than two-thirds of the earth's surface is covered by water, navigation is obviously important; nevertheless, all discussion of sea power starts from the fact that we are men, not fishes.

This alone should make us suspect the often-repeated statement that sea power must normally win wars—and especially the present war. Instead, on general principles it would be truer to argue that struggles between land animals usually must be decided on land. Of course, every war is a particular case, and generalizations have practical value only in so far as they help us to judge each one.

The importance of the question is obvious. To what extent could sea power, like an enormous boa constrictor—or as that good soldier and great American, Winfield Scott, said at the beginning of the Civil War, like "an anaconda"—strangle either ourselves or our opponents in the present war? If we decide that we can win by sea power alone or, in practice, by sea plus air power, then we need make no great land effort. On the other hand, great armies as well as great fleets may be needed. The decision is a job for the higher command alone. The rest of us, however, can and should help our commanders by grasping the elements of the problem so that we may back them by understanding their decision, whatever it may be, and by intelligently supporting that decision.

We need not fear at least to cross the threshold of strategy, for we have the word of the highest possible authorities—Napoleon, Clausewitz the great military philosopher, the first Von Moltke, etc.—that its elements are simplicity itself. Napoleon wrote: "The simplest maneuvers are best, and common sense is fundamental." It is only the combination of those elements into a wise decision which is almost infinitely difficult. Here, indeed, as Napoleon said of Sir Isaac Newton before the rise of Einstein and even more unusual persons: "We are constantly faced by calculations so delicate that they might make even Newton hesitate."

SEA power is chiefly the ability to "command" the sea; *i.e.*, to use overseas communications in war and to deny them to an enemy. Secondarily, weapons based upon ships, including carrier-borne aircraft, have a certain power of direct attack upon, or bombardment of, land areas within their range. For instance Nelson at Copenhagen, after defeating first the Danish fleet and then the floating batteries which covered the city's waterfront, threatened to bombard the Danish capital, whereat the Danish Government surrendered. Again, in 1916, the threat of a bombardment of Athens, the Greek capital, by the Allied fleet anchored in the Piræus, only six miles away, helped greatly to keep King Constantine and his government from joining the Germans. A recent English writer on "Sea Power," Capt. R. Grenfell, has reminded us that not only Copenhagen and Athens but also the financial capital of the United States and the capitals of Italy and of a number of lesser nations are within reach of naval guns. Nevertheless, the coercion of weak opponents seldom requires an all-out effort by a great power, and among great powers land-based weapons are usually so much stronger than sea-based ones as to keep fleets away from adequately defended localities.

The superiority of land-based weapons is as old as war. It has existed since the first savage, firm-footed on land, threw a spear against a rival in a canoe. There is an old French proverb that a single cannon on shore is worth a line of battleships in the sea. Ships are always comparatively fragile and difficult to conceal. Moreover, a chief effect of airplanes upon strategy has been to extend far out from land the zone in which land-based weapons should usually dominate sea-based ones. Accordingly, direct attack from the sea upon the land is secondary.

On our largely water covered planet, however, command of the sea is often fundamental. Except for wars in which at least one contestant is landlocked it must always play a part. Against islands not wholly self-supporting—and what island is so today?—it is formidable. So also against continental countries, to the extent that they depend upon products from overseas—as nearly all modern nations do. Further, the whole national strategy of continental nations, which, like the United States, have nothing to fear from the weakness of their land neighbors, is chiefly maritime. One cannot imagine any great war—except a civil war—which the United States could possibly wage without extensive naval operations by itself or its enemies.

Technically, command of the sea was never absolute. In the old wars, the weaker combatant always could get at least a few fast ships to sea. Today, the power of submarines to dive under and of airplanes to fly over water has, strictly speaking, reduced command of the sea to "command of the surface."

Even this, however, often has great military value because, in general, the economy of modern civilization, although politically divided into more or less independent nations, is world-wide. Almost everywhere habit has gone far toward making into necessities imports from distant lands. We in the United States, even if we had to live inside a Chinese wall which forbade all imports, could still live better than our great-great-grandparents because of the advance in physical science; but if we suddenly had to stop using tea, coffee, rubber, and tin we would have painful readjustments.

FURTHER than this we can concede nothing to the extraordinary delusion that superior sea power must necessarily win wars in general or the present war in particular. That delusion is widespread. It springs partly from the writings of Mahan but even more from the exaggerations of his ideas by injudicious followers. Take for instance the able journalist, Walter Lippmann, whose smooth, persuasive style

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*Author: "The Inquisition, A Political and Military Study of Its Establishment," 1923; "Warfare" (with Spalding and Wright), 1925; "The Turning Point of the Revolution," 1928; "The American Rich," 1930; "Can We Limit War?" 1934; "The Armed Horde," 1940. First Lieutenant, New York National Guard, 1916; Captain, Ordnance Department, U. S. Army, 1917; duty with General Staff, A.E.F., 1918. Member U. S. Section, Inter-Allied Armistice Commission, Spa, Belgium, 1918-1919.

is universally admired. When he wrote: "The chances of our sending another . . . army to Europe are . . . not in the reckoning," he was talking second-hand Mahan and probably also talking through his hat. When he called those who say that a large A.E.F. will be required to defeat the European Axis "irresponsible agitators," and "war-mongering" propagandists, he asserted a doubtful proposition which he cannot possibly prove. I quote him only because his eminence makes him prominent among Mahanists.

Returning to Mahan himself, the error which he did so much to spread is, like many other famous errors, easily understood when placed against its historical background. Before him, hardly anyone had broadly analyzed the great military effect of sea power. Many men had shown that they understood it. Soon after 1600, Francis Bacon had written: "He that commands the sea is at great liberty, for he can take as much or as little of the war as he will; whereas those that be strongest by land are many times nevertheless in great straits." Shakespeare, who wielded so different a style from Bacon, had sung of England as:

This fortress built by nature for herself . . .
This precious stone set in the silver sea,
Which serves it in the office of a wall,
Or as a moat defensive to a house,
Against the envy of less happier lands.

Indeed one might continue at some length in the same vein throughout the last three centuries of English literature. At the same time, no one before Mahan had systematically painted the broad picture. He reminded the English of a chief reason for their greatness and they were duly impressed. Not a few Germans, beginning with Kaiser Wilhelm II, fell into step behind him, and not a few Americans, led by Admiral Luce and Theodore Roosevelt. Military thought rushed violently into the near-vacuum which he had exposed.

What Mahan actually gave was by no means a sound, general analysis of war. It was a one-sided study of particular—one might almost say peculiar—sorts of war. Up to 1914, English sea power had won only under two conditions: Either the sole prize had been the control of valuable but undeveloped overseas territories easily dominated by sea command, or else England's naval opponents had also been compelled to great land efforts which she did not have to imitate.

Defensively, Mahan was right in saying that sea power must win since it can indefinitely keep large armies from crossing broad waters. To this extent his famous passage about the English fleet, "those storm-beaten ships which the Grand Army never saw," denying to Napoleon the mastery of the world by forbidding him to cross the Channel, is as true as when it was written. Apparent exceptions via air power, Crete for instance, mean only that airplanes extend much further from the land the zone in which land-based weapons can normally dominate sea-based ones, as we saw a few moments ago.

The defensive, however, is only a negative form of war. If it can prevent an enemy from beating us, so far so good. But that is very different from our beating him. If he persists in attacking unsuccessfully, we may tire him out. But if he stands pat we must either imitate him and see who is content to wait longer—like the two Chinese enemies each starving himself on the other's doorstep—or else we must attack. Only offensive action can aim at positive results.

Offensively, sea power can blockade. It can permit us to draw upon the resources of countries overseas for men and materials, and it can increase the effectiveness of friendly armies by giving them mobility. By themselves, however, fleets cannot invade and occupy hostile countries as victorious armies can.

NOW let us try to apply these general truths to the war in which we, in association with the English, the Union of Socialist Soviet Republics, the Chinese, and various lesser groups are engaged against the European Axis, Japan, and certain small European powers.

Blockades are effective according to the resources of the blockaded area. Against island powers dependent upon overseas communication, like England and Japan, they might, if sufficiently complete, be decisive. At the other end of the scale, no blockade could more than inconvenience the United States, and if Russia were able to defend its continental borders against invasion, then that vast country, like ourselves, could live by its own products. The European Axis holds a middle position, not so vulnerable to blockade as England and Japan but more so than Russia and the United States.

Since knowledge of war is chiefly a series of historical case studies, we should note that blockade alone seems never to have won a war within historic record.

Here we touch the center of the Mahanist heresy. Its author argued from the case of Napoleon. Starting from the undoubted truth that the economic stress resulting from the long struggle between the great Corsican's land power and England's sea power made continental Europe uncomfortable, he asserted that the English Navy "forced" the Emperor into his unwise invasions of Spain and Russia which finally destroyed him. The passage from "Influence of Sea Power on the French Revoution and Empire" is as follows: "Thus it was that the sea power of Great Britain, defying his (Napoleon's) efforts otherwise, forced him into the field of its own choosing, lured him, the great exemplar of concentrated effort, to scatter his forces and led him along a path which at last gave no choice except retreat in discomfiture or advance to certain ruin."

The operative word is "forced," but the idea, which was always doubtful, has weakened still further with the advance of historical science since Mahan's day. Business men in Napoleonic Europe were indeed inconvenienced by the British blockade, but business was then socially overshadowed by monarchs and nobles so that it politically counted for less than it does today. Mahan exaggerated the strain under which France labored. The French Admiral Castex, no great admirer of the Corsican, has collected much material showing that the economic condition of the blockaded French Empire, if not brilliant, was certainly comfortable. Moreover, such strain as existed was two-edged. England's then unrivaled banking power could not have held out indefinitely. Spain was Napoleon's inefficient but faithful ally. It is hard to see how he possibly could have been "forced" to invade her as he wantonly did. Mahan's idea is still weaker in the case of Russia which every one knew to be a tough nut to crack.

Erase the word "forced" and the imaginary omnipotence of sea power disappears. Not navies but armies supported by navies destroyed Napoleonic France. Federal armies supported by a navy broke the Confederacy in 1865. Not Jellicoe, Beatty, and Simms but Foch, Pershing, and Haig, with the admirals behind them, dethroned Wilhelm II.

Having disposed of the historical cases, we can consider the present war on its merits. How long it might take sea power alone to defeat the European Axis by blockade, we shall never know, for great armies are in the field on both sides and will almost certainly stay there. To the extent that either set of land animals can conquer, hold, and pacify territory, that side will be so much ahead. Accordingly, the real question is: How much could blockade contribute to the defeat of either side in a long war?

AS to an Axis defeat, the answer is hard to find. In these matters nothing is more unreliable than statistics, for man is adaptable and resourceful. His body is controlled by an unpredictable spirit which, after seeming dead, has often risen from its grave to confound materialistic fools.

In the last war, the writer had every opportunity to discover how difficult it was to learn the extent to which the highly effective blockade of that day was pinching Germany and the impossibility of telling how much that pinch was squeezing the German spirit. In the end, the Germans did not spin out a last-ditch resistance as they might have. But they did fight until, by the Armistice, they had only a possible maximum of two of their shrunken divisions sufficiently rested to counterattack. And probably both of these had been broken up weeks before.

Today, as in former wars, blockade is two-edged. As we have seen, England's need to import food makes it certain that a weakening of her sea power and that of her associates in British waters would mean her surrender. Her overseas communications must be carried almost entirely in ships which can be sunk and are therefore more fragile than land communications. The small minority of passengers and freight which can move in and out of Engand by air must go in planes which are still more fragile.

Another point is that an overseas, world-wide economy in itself is more delicate and less easily able to stand the strain of prolonged mass warfare than a localized, autarchic economy based on the exchange of domestic products and especially upon domestic agriculture. Captain Grenfell, whom we have already quoted, speaks of "the general delicacy" of "international trade under strain." The reason is that world-wide exchange depends upon foreigners' ideas of the value of one's money, or of money plus credit, which comes to the same thing. For instance, Argentines and Brazilians, if not convinced of the value of dollars and sterling, might refuse to exchange their valuable products against those currencies. Thus, in a world-wide economy, there must be a continual drain of real values to neutrals from belligerents who are trading overseas. By contrast, a closed economy can use token money. Sweden or France today cannot quarrel much with anything which the Germans choose to call a mark. As schoolboys, had we been interested in military finance, we might have noted similar forces at work in the Peloponnesian War between wealthy but world-trading Athens and poor but autarchic Sparta. The Spartans won!

ABANDONING the untenable position that sea power alone must in the long run defeat its enemies by blockade, let us examine the more modest claim that it might do so by blockade plus the mobility which it can give to friendly armies even though these last are less numerous than those of the superior land power. Here again we find the talented Walter Lippmann writing of "the superiority in mobility of navies over armies to threaten land power at more points than an army can hope to defend." It would be better to say that a sea power, wishing to start a land campaign against superior land power, may or may not find a theater of war to which its sea communications are better than the communications of the land power. The classic instance is Napoleonic Spain where the French often had to have sixty per cent of their total force in their rear areas, guarding their excessively difficult supply lines. Communications are to an army what roots are to plants or an air hose to a diver. Few sea powers, however, can hope for such a Christmas gift as Napoleon's invasion of Spain was to England. Moreover, the airplane plus rapid land transport makes it peculiarly difficult to force a permanent landing against opposition. Few cargo ships can do twelve sea miles an hour.

Writing in December 1941, the European Axis has only one overseas outpost, Tripolitana. Numerically, the Axis forces there are trivial. When the British offensive began in November, the hostile armored divisions south of the Mediterranean numbered only two German and one Italian, whereas the total German strength was recently estimated at three hundred divisions, of which no less than sixty-five were panzers or other élite units.

Obviously, throughout the whole Mediterranean theater the appropriate military instrument is the navy-air-army team, but only if great Axis armies were unwisely advanced southward far beyond their present positions could we hope to find a theater as favorable as Napoleonic Spain in which to entomb them. Gibraltar, Suez, and the agricultural wealth of Egypt are indeed great temptations, but those temptations might be our enemies' undoing.

On our side, it would take too long to discuss how sea power might help us to seize various islands. De Gaulle has written: "To hold Sardinia is to dominate the Western Mediterranean." These possibilities, however, take us beyond the subject of naval superiority. They force us to ask: What armies, what transport and cargo shipping, and what invaluable auxiliaries in the shape of land- and sea-based planes are or soon will be available?

IN conclusion, superior sea power, including its air component, could indefinitely defend the continental United States. It has played and will continue to play a great part in defending England. As this writer recently said in another place,* we may contrast the failure to date of the German Air Force, outnumbering the English three to one, to compel a British surrender with the undoubted fact that no sane English government would even have tried to resist an equal numerical superiority in good, competently manned surface ships.

Offensively, blockade might bring down Japan and is a valuable weapon against Axis Europe. Whether blockade alone could defeat Italy and Germany is academic, for it is now supplemented by Russian and British armies, probably soon to be joined by American. Unaided by armies, sea power may or may not win wars; probably not, since we are land animals. Navies are not necessarily omnipotent.

EDITOR'S NOTE.—"The Great Pacific War," by the late Hector C. Bywater, noted British naval expert, has just been re-issued by Houghton Mifflin Company with an introduction by Hanson W. Baldwin of the *New York Times*. Today, every page reads like an actual record of the Pacific war.

*"No Separate Air Force," by Hoffman Nickerson. *Harper's Magazine*, December 1941, No. 1099, p. 10.

New Mobile Weapons

One of the Army's latest mechanized weapons, the "swamp buggy," above, mounting a 37-mm. gun has proved itself an effective antitank unit; its oversize tires enable it to navigate marshy terrain. Another new weapon is the 240-mm. howitzer which breaks into two loads for fast transport. The barrel is shown below being towed at high speed (Acme photos).

Antitank Defense

Antitank tactics are being stressed more and more by the Army as the threat of mechanized warfare grows greater. Above, 37-mm. and 75-mm. antitank guns are shown repulsing a tank attack on a Louisiana town during Third Army maneuvers, while below, riflemen of the Second Army are on the alert against infantry attack on their antitank gun position.

Men and Machines—Both Vital to the Army

The infantry is still the backbone of the Army, for it must consolidate and hold the gains made by the armored forces. The new helmet, shown above, affords greater protection than the old model and soon will be worn by all troops. Four different types of Armored Force vehicles are shown below: a half-track scout car, motorcycle, "jeep," and light tank (Acme photo).

Training to Repel the Air Raider

Antiaircraft defense of fixed positions and moving columns is another important element in Army training. Coast Artillery troops with the 26th Division in South Carolina are shown above operating a fire-control box for the 37-mm. antiaircraft gun in the background (Acme photo). Below, motorized troops defend a Watersee River crossing against dive bombers.

The Fighting Unit

A Proposal for the Organization of Our New Divisions

Brig. Gen. Henry J. Reilly*

OUR Army is to be increased by many new divisions—the organization of some of them already has begun. Therefore, this is the time to ask: Have we yet found the best organization to meet the conditions under which our new Army will have to move and fight?

Since President Roosevelt's speech promising the use of our troops anywhere in the world where they may be needed to defeat the Axis powers and Japan, it is obvious that we must be prepared to fight "from Greenland's icy mountains to India's coral strands." It is equally obvious that our divisions will have to travel by road, by rail, by sea, and, in some of the theaters of war in which they may operate, particularly those comprising both land and sea, the use of aviation for troop transport will greatly facilitate effective operations.

As long as we are planning an immense aviation program, why not include in it large numbers of troop transport planes. If we do, we can remove the carrying of troops by this method from the category of a special operation with specially trained troops and make it as normal a means of transport as that by motor truck already has become.

The industrial revolution put sea power into the hands of the industrial nations because the others lacked the means to build steel warships. There are many signs that the same transformation has finally taken place on land. When visiting the Baltic countries prior to the outbreak of the war, this writer was told again and again that these countries, lacking the industry to produce modern armament, knew the hopelessness of fighting Germany unless Britain and the United States would furnish the aviation, the tanks, and the other mechanized means of warfare which they could not produce themselves. Throughout the Balkans I heard the same thing in every capital. In Turkey it was made very clear that unless Britain and the United States would provide the immense amount of modern armament which only modern industry can produce, the Turks knew they could not withstand a German onslaught.

General Pariani, the Under Minister of War of Italy, told this writer when he was visiting Rome, after seeing the Spanish Civil War, the plans he had made to rearm the Italian Army in accordance with the lessons of that war.

BEFORE Germany entered the present war she had succeeded in making the changes in her armament which the Spanish Civil War had taught her to be necessary. On the other hand, Italy had hardly commenced, due partially to the political changes which led to Pariani's relief but also to the fact that Italy's industry was incapable of rapidly making the changes which Germany's industry carried out with such facility.

President Roosevelt's announced tremendous armament plan, based on the full use of our industry for war purposes, gives this country the opportunity to arm its forces with the best and latest types of armament and matériel without imposing any restrictions as to numbers. Therefore, there is no reason why we should not plan an organization of our Army based solely on giving it the maximum force in combat and the maximum mobility for strategical movement. Perhaps up to the present there has been too much of a tendency merely to copy the Germans. There is no reason now why we should not go ahead to produce the kind of an army the Germans would produce as the result of the lessons they have learned to date if they had our tremendous resources.

WE still call a combination of infantry and artillery with the necessary services a "division." We still call a unit made up of two or more divisions an "army corps." These names are convenient, and there is no reason why they should not be continued in use—unless by doing so we imprison too many minds in conceptions which belonged to armies before the Industrial Revolution did for them what it did for navies about a century previous. In discussing the organization of a division, there is generally so much reference to the past that it is sometimes fair to ask if the attempt isn't being made to fit modern armament to the tactical needs of the past instead of evolving new tactics and organization to fit not only existing modern armament but any new types which industry can produce.

Formerly, man power was the basis of tactics. Today, while fire power is the basis, too many of our enthusiasts for newer methods confuse weapons—the producers of fire power—with weapon carriers. An armored car, a tank, an airplane, are not weapons; they are merely weapon carriers. Like the submarine, the destroyer, the cruiser, the battleship, their combat value depends upon their ability to produce results in battle; that is, their ability to carry effective weapons and to keep the enemy from silencing those weapons by his fire. Only the airplane carrier bears a classification which clearly shows that it is not a weapon but a carrier. In this case it is a carrier of the weapon carriers—the airplanes which belong to it.

Another great error made by the enthusiasts is the tendency to confuse speed with mobility. The most mobile weapon carriers are frequently not the speediest. Armored cars can go at a speed beyond that of tanks. Tanks, however, can cover terrain which armored cars cannot negotiate. A heavily armed and armored tank has mobility in battle denied a speedier tank carrying less armament than armor because it can survive hard combat where the lighter tank is destroyed due to its lack of combat power. In other words, it must be kept out of the zones too dangerous for its powers or be destroyed. Therefore it has no mobility in those zones.

So much for the new conditions resulting from the Industrial Revolution. How are they to be taken advantage of from the point of view of organizing our divisions?

From the Spanish Civil War to date, there have been certain marked tendencies produced by combat which cannot be ignored. This writer is sure of this because he saw them

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Signal Corps

LIGHT ARTILLERY CAN GIVE CLOSE SUPPORT TO AN ATTACKING DIVISION

develop on Spanish battlefields. He saw some phases of them in Albania when the Italians seized it. He was in France for a number of months after the declaration of war. He has recently returned from a number of months in France collecting data from Frenchmen who participated in the war and from a number of months in Switzerland checking on the campaign from the German side.

Such information as has been available since he left Europe about combat in North Africa, Russia, and now in the Far East, bears out these conclusions. The most important is: The basis of modern organization must be combined action by all arms with all available weapons so that the maximum powers of each are used to reënforce the powers of the others and the limitations of each are protected from the enemy by the powers of one or more of the others; in other words, each arm *with* and never *versus* or *in place of* another arm.

This has resulted more and more in small combat units made up, not of one arm as in the past, but of enough of the different arms to insure carrying out the tactical missions intrusted to the unit. In Spain, each infantry unit, down to and including the platoon, had under the control of its commander every weapon needed to insure its advance on the offensive and its successful resistance on the defensive in its own zone of action. In other words, the platoon commander had his own trench mortars and his own light machine guns but not heavy machine guns and field guns. The battalion commander had under his control the weapons needed for his zone of action; the same was true of the regimental commander.

Every Italian infantry regiment had a battery of nine mountain guns. They were found to be extremely useful for missions not easily carried out by the divisional artillery. The Spanish always expressed themselves as believers in these regimental batteries.

In general, it might be said that the commander of each echelon had as an integral part of his command all the weapons needed to carry out his mission which could be used in his zone of operation. And these must not be such big targets that the enemy's fire would soon destroy them. It is important to remember that targets which are too big for the zone in which they are being used not only are destroyed but attract so much enemy fire that they lead to the destruction of the very infantry soldiers they are supposed to help. In other words, a wrong combination of different arms in the endeavor to make a complete modern combat unit, far from increasing combat power may lessen it by leading to greater losses from the enemy's fire and by putting out of action powerful weapons which, if properly placed further to the rear, could be of great assistance.

THE establishment of combat teams in our Army is a move in accord with the correct principles of modern combat. It is a natural result of the infantryman's desire to have under his control the artillery support which he knows he needs. On the other hand, it is questionable if field artillery, as assigned to these combat teams, is of the type which can best give him that support. There is no doubt that the combat teams, as at present organized, tend to rob the divisional artillery of its most important power—that of a brutal, concentrated fire on any target which the division commander wishes to destroy in order to insure the advance of his division on the offensive and its protection on the defensive. In other words, under the present set-up, artillery fire too often is scattered throughout two or three infantry regimental zones instead of being concentrated on the target which is most important to the division as a whole.

The answer is to distinguish carefully the zones in which the infantry absolutely needs some type of artillery in its own hands from the zones which have to do with the division as a whole. By artillery is meant everything from a trench mortar up.

The infantry now has its trench mortars. Is there any reason why it should not have antitank guns on self-propelled mounts which also could be used as accompanying guns during an assault? These guns, of course, must have a low silhouette in order to survive enemy fire in the infantry zone of combat. Similarly, the infantry should have the lighter antiaircraft guns needed for close defense against diving enemy airplanes.

So armed, the infantry would have the artillery needed

Signal Corps

INFANTRYMEN IN "JEEPS" SUPPORT THEIR OWN ADVANCE WITH TRENCH MORTARS

for its immediate protection and operations. It might be called the "infantry-artillery." This would free the field artillery for use against objectives which are properly divisional objectives and would obviate the scattering of artillery fire, which happens only too often under the present combat-team system. This would insure the brutal, concentrated fire which is the principal quality of artillery properly employed.

One of the chief characteristics of the war of 1917-1918 was the tendency to increase the proportion of artillery to riflemen, and this tendency has gone steadily ahead. In that war, there never was enough artillery for heavy combat in proportion to the infantry, unless the artillery of one or more other divisions was used to support the infantry of the division in line. Today, the infantry also must have antitank and antiaircraft artillery.

The division of four regiments of infantry, due to the constant increase of the number and types of its weapons, became unwieldy in the war of 1914-1918. Today, if the triangular division of three regiments of infantry is given all its support weapons, it is not too unwieldy to meet the demands of modern combat and transportation.

The reports from Europe indicate a growing tendency in the German Army to use combat units each made up of an infantry regiment with the necessary artillery, communications, engineers, and services. The Italians experimented for some years with a division of two infantry regiments with a greater proportion of artillery support than that assigned to a 3-regiment division. In the final campaign in the Spanish Civil War, these binary divisions were found satisfactory from the point of view of command, flexibility in combat, mobility, and supply.

In the campaign in France which led to her downfall, the French triangular division was not satisfactory: The proportion of artillery to infantry was too low; having a chief of infantry between the division commander and the three colonels complicated the command—it slowed down the response of the infantry to the will of the division commander and complicated liaison with the artillery. Communications of all kinds were too slow. With three regiments of infantry, the tendency was to assign a division a greater length of front, thereby leaving it fewer reserves than nine battalions of infantry should be asked to defend. There was too much overhead for the number of combat troops in the division, the army corps, and the army from the points of view of command, supply, and transportation. This writer has many details, carefully gathered from competent sources in France, which show these defects to be among the major causes of the French defeat.

THIS writer previously* has proposed a division of two regiments of infantry of four battalions each and one regiment of field artillery of four battalions, the one field-artillery colonel and two infantry colonels being directly under a major general, commanding. (With all the new divisions, army corps, and armies to be created, and the new camps, replacement centers, etc., there will be plenty of promotion for existing brigadier generals and commands for new ones.)

Such a division gives the commanding general direct control and insures immediate response to his will. He can command surrounded and protected by his own troops executing their normal missions instead of being cut off and captured as happened so often in France, or having to detach troops for a headquarters guard, as has happened in maneuvers.

Such a division easily can have its nonmotorized or nonmechanized parts transported by motor truck. In fact, the Chief of Field Artillery, on June 24, 1940, recommended that a division of this type be organized as a motorized division and tried out. Such a division will take fewer railway trains, will load more easily into ships for sea transport, and, once we have built enough planes, it should be possible to transport it by air, except, perhaps, for its field artillery. The question of supply would be simplified considerably because of the smaller number of regimental and independent units. Communications within the division would be simplified.

Any one can figure out quickly the saving in overhead for divisions of this type and for army corps made up of a number of them. It seems a logical combat unit for the new period ushered in on land by the Industrial Revolution.

*"The Ideal Combat Unit," ARMY ORDNANCE, May-June, 1940 (Vol. XX, No. 120, p. 381).

Blackouts

Their Relation to Industrial Plant Protection

Fred D. McHugh *

THERE is no such thing as a complete blackout; a city or an industrial community is not hidden by a blackout; a city is not necessarily saved by a blackout. To the uninitiated person who has heard and read of blackouts for years but who never has experienced one, these statements may sound like rank heresy. To such a person, a blackout is just what its name implies, and to be satisfied with something short of complete darkness would be unpatriotic.

It will come as a distinct surprise to many people to learn that the city of Bristol, England, recently decided to spend 20,000 pounds sterling on new modified street lighting for a "brighter winter." Bristol has been bombed repeatedly, and its residential as well as its industrial areas have suffered heavily. Yet Bristol authorities came to the conclusion that an absence of lighting was not saving the city and that there was no point in depriving it of a reasonable amount of light; and certainly Bristol's raid experience qualifies them to speak on this subject.

From the first, the blackout in London was something short of that total darkness so many people believed was invoked by the authorities. Traffic went on its way with the most inadequate sort of light slits where headlights used to be. The pale, less-than-candlelight glow of street lights came through slits left in the paint over the glass lenses, and the slits themselves were covered with heavy paper. Pedestrians all carried flashlights which also had coverings over the lenses and, in addition, switches that operated only when the light was pointed downward—poor lights on the whole, but lights nevertheless.

Even from the first, there was no thought of permitting an air raid to tie up the complex activities of English cities, for if such had been the case the Nazi aim of disrupting the life and work of England at war would have been accomplished. Rapidly, after the first hectic days, the various cities settled down to "take it" and carry on. People still had to do their work, industry had to be kept going, the war had to be prosecuted with vigor. None of these things could be accomplished in total darkness. Lighting restrictions were lessened, so that it became possible for store windows to show pale lights behind baffles that prevented upward reflection and on the condition that they be put out completely on sounding of the alert. A person could light a cigarette in the street if he would cup it in his hands and permit no flare-up of light. Small electric signs were allowed back in doorways; colored traffic lights continued to be used; and there were many lighted signs, well shielded, pointing to shelters and gas-decontaminating stations. There were no restrictions of any kind on indoor lighting, but owners of dwellings, cafés, hotels, and other structures were held criminally liable if they allowed any light to show outside.

It must be admitted that it does look dark in London at night, and the average person would not believe that the city can still be seen from the air. Yet when reconnaissance planes went up to make a determination of visibility under full blackout conditions, they could still see the outline of the city as a faint glow at 20,000 feet altitude. And at 5,000 feet, they could see the streets and follow the moving traffic! Fortunately, the barrage balloons keep enemies above that height.

THE blackout is intended primarily to confuse and misdirect enemy raiders. It does this by changing or eliminating the pattern of known lighting systems over wide areas. The blackout thus prevents discovery to the enemy of particular targets in a city or industrial area; it prevents use of a locality's known pattern of streets as a guide to near-by objectives; finally, it saves a community from "unloading" bombardment. The last type occurs when the enemy, having been forced to turn homeward with his bombs, simply unloads them on any specks of light he may see on the way.

It would be useless to black out the city of San Francisco, for example, and fail to do a complete job at Oakland, Alameda, Berkeley, and other near-by centers. The enemy would certainly know the pattern of lights in all these communities, and if any one of them was lighted it would act as efficiently as a compass to direct fliers to the city and its important bridges. The futility of blacking out only one part of a large and populous section was shown in a recent test blackout in Newark, N. J. From airplanes flying overhead, observers could see a very slight glow from the city itself. But the familiar pattern of lights in surrounding suburban towns was enough, the observers said, to direct any fliers to the heart of Newark.

All areas that could be of any possible value to enemy raiders should, therefore, be blacked out in any given raid, and orders to that effect probably will go out from military authorities when the time comes. London has a blackout in effect every night, and many of the permissible dim lights are doused when the alert sounds. It is doubtful if any American communities will have to go as far as that, but the war is young yet—our part of it. A few months ago, the War Department helped to prepare a bulletin on blackouts in which the statement was made that, if war came, "areas within 300 to 600 miles of enemy front lines *or the seacoast* probably will be required to black out every night." This belief has since been modified, and very little effort has been made (up to mid-January) to plan blackout procedure in important centers on the East Coast.

Civilian Defense authorities are responsible for giving to raid-endangered populations full instructions on blackouts before they are needed. Those authorities also organize the many civilian air-raid services, but they cannot be expected to perform these functions for industrial plants and other large commercial enterprises. It is especially necessary for such organizations to establish their own air-raid squads to take care of all contingencies during a raid, for the sort of damage that may occur in an industrial plant and the type and extent of wounds to personnel often are peculiar to the kind of work carried on there. Furthermore, the familiarity of the employees with the factory as a whole, with its raw materials, finished products, and the particular value of spe-

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cial machinery, will guide them in combating raid effects.

The industrialist who has not already done so should lose no time in organizing plant-protection and training squads among his employees. That does not mean that any one plant should arbitrarily take the extreme view of the situation and adopt every measure suggested by the military and the Office of Civilian Defense. In the protection of plants, as well as of cities, careful judgment must be exercised so that there will not be too much or too little. Protective measures will be modified and adjusted to fit local conditions.

By local conditions, however, are not meant simply the physical structure of the property, the number of persons employed, and whether or not it is making vital war supplies. It must not give a compass bearing to a near-by objective. Moreover, a blackout that may be perfectly satisfactory to the plant owners can be dangerous to cities or factories either near by or miles away. A saw-tooth roof of skylights might be blacked out within, but might still be troublesome. When searchlights probe the night sky for raiders, all this glass catches the light glow from the sky and throws sharp reflections so that the roof still offers a definite pattern for the guidance of fliers. Paint with a matted finish may be the best solution to this problem. Another thing that has showed up in practice blackouts is the reflection of searchlight beams from the roofs of parked cars—which brings up the question of what to do with factory parking yards. Further tests may be necessary to determine the importance of this factor, but this writer suggests a dark tarpaulin over each car, or a black-dyed bedsheet.

The factory owner has the responsibility of protecting his factory, but he hasn't an entirely free hand. He must not only consult local officials to coördinate his blackout plans with theirs but also must learn the opinions of the military, though the latter may have no defense forces within miles of the plant. Planning should be thorough; materials should be collected preparatory to installation but actual work held in abeyance until the Office of Civilian Defense gives the word that it is necessary. Something might be said here, parenthetically, about a bad national habit of locking the barn afterward!

The general survey of a plant prior to establishment of blackout measures will discover areas, special machines, and services that require individual attention. Safeguarding these will often affect the blacking-out process, for if parts of a factory near key operations or near essential services are blasted open, operations may not be resumed until after repairs are made and lights go on again. There is, of course, little that can be done about direct bomb hits, but where there are a number of floors it sometimes is possible to rearrange vital pieces of machinery on lower floors for greater protection; sometimes it may be advisable to shield some of these with individual walls of sandbags or structural materials. These protective measures pertain only indirectly to the blackout—but indirect factors often mean life and death in air raids. It may be the overlooked indirect factor that, when the very first raid comes, will invite disaster or at best force cessation of operation and extinguishment of all lights.

FIRST consideration in planning the plant blackout is the question of outside lights. None will be permitted in a blackout area except with special permission, and the controlled lights that are permitted must be dim, shaded with blue glass, and be put out completely when the alert signal is given. Inside, the factory processes must continue, and lights must be undimmed; however, no light may be allowed to escape through windows, skylights, or doors. Windowless factories, with scientific lighting and air conditioning, need no special attention except the provision of light locks at the entrances. Other plants can put opaque shutters over windows or adopt any one of a number of expedients to prevent leakage of light. They, too, need light locks at entrances. Ventilation should be provided if not already existing. Outside in the factory yard, white lines should be painted on traffic ways, on obstructions, and other objects. Water tanks painted aluminum should be given a coat of nonreflecting dark paint, and the same treatment is indicated for marble or white-concrete construction, tin, and other bright materials.

There are certain industries that can neither dim the lights of their operations nor cease work. When blast furnaces of steel mills send their orange flames into the air, it is not possible to stop the light until the furnace is tapped and its molten metal poured. These furnaces operate in rows in a regular sequence, and it would be impossible to stop the operation of a row of them without seriously affecting production. Certain other industries are also violators of the blackout regulations—coke by-product ovens, potteries, gas plants, and others—and some of these might have to be checked in special areas. Some work, however, has been done in designing blackout equipment for certain of these types of offenders.

WINDOW and skylight glass is the greatest problem in blacking out a plant. The glass must not transmit light nor must it reflect light from searchlights, incendiary fires, or the moon; it must, if possible, admit daylight. This problem may be solved by use of removable shields. The glass must not endanger workmen with glass splinters when a bomb bursts near by. Some arrangement for protection from the weather must be made in case all glass should be blown out. The blackout material should be noncombustible, if possible, and, in the case of food factories, consideration should be given to the insect-resistant qualities of the materials used. Gas-proofing of blackout construction, for the safety of individuals, is not of great consequence; London experience shows that the first bomb blast rips open all such construction and indicates that sole reliance should be placed on the gas mask.

Glass splinters fall from skylights and are blown from windows with great force when bombs burst near by; hence windows in key positions are often glazed with laminated safety glass or various plastic substitutes. One noncombustible cellulose-acetate plastic material, 0.08 of an inch thick and reënforced with welded wire mesh, costs about 80 cents a square foot, being sold in sheets 61 by 27 inches. A thinner type, 0.022 of an inch thick, costs about 30 cents a square foot, this being sold in sheets 55 by 24 inches.

In frequently bombed areas, windows should not be reglazed over and over but simply boarded up or, better, protected with fragment-resisting construction. Light-steel sheeting would provide good protection against glass splinters and against incendiaries as well. In doors and windows of offices and control rooms of factories, special heavy shutters can be erected to assure noninterruption of work. When steel shutters are prohibitively expensive, mattresses made of metal wool four inches thick and quilted or buttoned to hold their shape, can be provided and suspended on hooks outside important windows. The mattresses, of course, should be larger than the windows.

There have been suggestions made regarding the use of lights and tinted windows to do the job of the blackout rather than painting windows and cutting off daylight altogether. Such a system might, for example, make use of orange lights and pale blue glass panes. The glass would admit considerable daylight, and the orange lights would give sufficient light for work to be done, but very little light would pass through the glass at night as the blue would filter out the orange. Systems of this sort would have advantages in some businesses, but would be too costly for general plant adoption. It would be more satisfactory to close up all window openings and install scientific lights and air conditioning.

The simplest window blackout is, of course, paint. And the paint used should be serviceable and easily removed, for paint-removal costs ordinarily are about three times application costs. The coating should be placed, by spray gun or brush, on the outside of the window so that it will cut down the reflectivity of the glass. A good paint for the purpose can be made up as follows: 100 pounds of black ground in oil; 50 pounds of paste dryer; 2 gallons of turpentine; ½-gallon of boiled linseed oil; 1 pint of terebene. This will make 10 gallons of blackout paint. For the stripping operation, the following is suitable: 5 gallons of benzene; 3.3 gallons of acetone; 15 pounds of paraffin wax. This formula gives 10 gallons of paint remover.

But the use of coatings for the glass itself does not obviate the need for protection against glass splinters, and it is often better to provide a combination of protection in one installation. Plywood shutters, waterproofed and made light for easy handling by youths and girls, might be installed inside windows to give perfect blackout conditions, prevent flying glass, and keep out the weather if the glass were blown out. Another plan is to place inside windows a light frame on which has been stretched a rubberized cotton fabric. This is so arranged and mounted that a bomb blast merely lifts it out of place without destroying it, and replacement is easy. Fabric of most any type, if it is dark in color and lightproof, and also many different kinds of papers may be used for blackout purposes. Any one of these is simply pasted over the glass pane itself or over the window frames. Paper should be quite opaque and should be used in double or triple thicknesses.

Skylights are usually indispensable in factories having them, for some manufacturing processes depend upon daylight. Special arrangements will often have to be made in such cases. One type of protective construction consists of a galvanized tray mounted under a skylight on horizontal rods and arranged to slide from side to side. This is satisfactory for single skylights or rows of them, but where there are long, continuous stretches of saw-tooth roof lights, some ingenuity may be necessary in solving the problem. One arrangement would be a camouflaged tarpaulin on a roller over each line of skylights. This roller would be installed to operate from within the plant and roll up very much like an awning. Special hinges along the ridge of the saw-tooth would be necessary to operate another type of light shield made of camouflaged fiber board. This would swing into place on the outside over some or all the panes in the saw-tooth slope —the "some" being permissible when the glass in alternate bays is painted out. Internal sliding shutters of plywood, fiber board, opaque fabric or paper and wire on wooden frames would be easy for the chief engineer's office or perhaps the master mechanic to work out, make, and install. A combination of outside tarpaulin and inside roller blind is the essence of still another arrangement, this type giving considerable protection against shattered glass.

In blacking out any factory, ventilation should be carefully considered. If the plant is large and barnlike, as are many of those in heavy industry, there probably will be a leakage of air sufficient for all employees. It may be necessary to install ventilator fans in some cases, and these should be installed with louvers or some sort of baffle plates to prevent light leakage. More efficient, of course, is a regular system of intake and exhaust air pipes, but these systems are expensive and may not be advisable. When light-tight louvers in monitor-type construction may be opened, they will serve as outlets for rising vitiated air while fresh air is allowed to flow in at ground level through the light locks at the entrances. These light locks are necessary to permit entrance and exit of employees during blackouts. They are vertical baffles—or walls—built at doorways and so arranged that persons walking through them must make several sharp turns to get through. The passages nearly turn back upon themselves, and the interior is painted a dark color so there is no chance for the light to leak out or be reflected along the wall surfaces. Sometimes such locks will be built on the inside of entrances, sometimes on the outside. Straight-through doors are provided as emergency exits.

Hand trucks moving about the plant could not use the maze-like entrances, so light locks for their use should go straight through with swinging doors at each end. For loading and unloading motor trucks backed up to factory platforms, a simple system of portable screens can be used. These would be overlapped, standing in the spaces between the various trucks. Some provision, of course, will have to be made for the space between the truck top and the roof of the platform. This could be covered with a short curtain of heavy fabric. Portable inclosures for the rear end of the truck or for the side of the truck for side loading are also contemplated. These are large box-like affairs on rollers, and carry their own fringe of curtain to close in about the truck.

Industrial smoke could defeat the purpose of a blackout, but it is possible that during a raid smoke may be used extensively to enhance the confusion effect. To do this, volumes of smoke would be exhausted from the usual plant stacks but additional smoke clouds would be set off in patterns that would tend to confuse. But whether smoke is advisable or not in any given locality remains for the military to decide, though key personnel of the Office of Civilian Defense also will know the conditions applying at any time.

Blackouts may be important to us or they may not be—we don't know whether air raids will come—but we do know that all manufacturing is important. We have a huge job to do, and, if we are not prepared, bombs may make us dispense with some vital parts of our industry. So whether the bombs come or not, plans should be made for the sort of blackout that will be needed if raids do start. A frantic scramble at the last minute will only add immeasurably to the confusion.

EDITOR'S NOTE.—For more complete treatment of the above subject, readers are referred to the pamphlet "Blackouts" prepared under the direction of the Chief of Engineers, U. S. Army, with suggestions of the National Technological Civil Protection Committee. It is published by the U. S. Government Printing Office and is for sale by the Superintendent of Documents, Washington, D. C., at 25 cents a copy.

Protective Concealment

Modern Camouflage Must Deceive the Camera as well as the Eye

Maj. Peter Rodyenko*

PROTECTIVE concealment—or camouflage as it used to be called—is a subject of vast importance in time of war. It is apparently forgotten afterward. For years, the majority of nations did little about it in their armies, but there were, throughout the world, a few individuals who were personally interested in it and who saw the tremendous possibilities of protective concealment—but they were voices in the wilderness.

After the World War, no country was interested in arts pertaining to warfare, except one nation—Germany. When the present régime ascended to power, and even a few years before that, the German Reich was making very elaborate preparations for protective concealment. This study was carried on not only by the army but also by qualified civilians. They enlisted the services of scientists and other technical men and conducted a study which had one very vital objective—war-time protection. Germany has been repeatedly bombed by the R.A.F. and also, of late, by the Soviet Air Force. Yet it is an admitted fact that the majority of German industrial plants were, if at all, located with difficulty—they were so well concealed. Other nations failed in protective concealment, and they have had to pay for their neglect.

Camouflage, during the World War, was generally left to artists. Only in the latter part of that war, shortly before the Armistice, were any attempts made to treat the subject scientifically. It was generally a hit-and-miss affair, left to guesswork and experimentation; and while some of these artists did remarkably good work, the great majority of their structures probably supplied some of the comic-strip artists with inspiration for their masterpieces.

Protective concealment may be an art, but it is based on definitely established scientific facts. It can be compared with the work of the plastic surgeon. Plastic surgery is an art, but the practitioner has to be a medical man for very obvious reasons. Just so, an individual engaging in activities of protective concealment must be technically trained; he must be familiar with the scientific facts and laws on which protective concealment is based. Just as not every medical man will be able to practice plastic surgery with success, so it does not necessarily follow that every architect or engineer will make a good camouflager. There are certain psychological aspects to it, mainly imagination, ability to visualize what things look like when seen from several thousand feet in the air, a certain gift of observation, and a painstaking desire to take care of details without ever losing the central idea. That perhaps may account for the fact that there are very few people who, up to this moment, have engaged in the study of protective concealment.

Protective concealment can well be divided into two main classes: First, the planning of new civilian establishments and, secondly, what to do with existing plants, factories, and other important civilian establishments.

In Germany for more than the past twelve years any concern that was desirous of constructing a new plant had to submit the plans to a certain government agency for approval and for the inclusion of protective-concealment features. Any architect or engineer who prepared plans for plants of importance and failed to submit them to a definite, established government agency was very heavily fined and deprived of his license for several months. Thus the German Reich succeeded in making the practice of protective concealment universal. In the United States we do not now have the time to do that. We do not have ten or more years to prepare. Our problem is what to do with existing industrial establishments.

THE purpose of protective concealment is to prevent detection on aërial photographs and visual observation by a bombardier. While I have great admiration for the British nation and their brave army, I must say that the British failed to be as thorough in their preparations as the Germans, for they attempted to provide protection only against visual observation by a bombardier who has to pick up his target only a few minutes before he passes over it.

The German method admits the correctness of this fact, yet at the same time makes considerable effort to provide protection against aërial photography preceding the mission trip of the bombardier. The Germans did not send bombardiers out on a haphazard mission. The bombardiers were not told to load their ships with bombs, fly around, pick up targets, and then bomb them. Just as the course of a ship is carefully laid out and then equally as carefully followed, so a course, called a flightline, is laid out for the bombardier by means of maps and aërial photographs, previously obtained. The bombardier is shown the photographs and maps; he is shown the flightline, the course he is to follow, and he is told which target to bomb.

Now, reason the Germans, if protective concealment of an establishment has been executed so as to provide protection against aërial photography to such a degree that it cannot be spotted on an aërial photograph, the bombardier sent to bomb this particular target starts out with a psychological handicap. He does not know exactly where the target is located. He is merely told or shown the approximate location of the target he is to destroy; he himself is supposed to pick it up through his bombsight. Such a psychological handicap creates uncertainty on the part of the bombardier.

FOR several months last fall, no observation planes had been sighted over England. But every bombing plane of any nation that can afford to possess bombers will carry in the tail turret an aërial photographic camera which can be used by the man who also serves as the tail turret gunner. Aërial photographs are constantly taken. They not only serve as a "score card" for the bomber but upon its return the photographs are carefully studied and compared with those previously taken. There is reason to believe that the Germans now carry two cameras in the tail turrets, one loaded with panchromatic film and the other with infra-red film.

The three basic principles of protective concealment have

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not changed for thousands of years. One is concealment; another is confusion of identity, and the third is the use of decoys or dummies. If something is concealed so well that it can't be seen and so well that it can't be spotted, then, of course, it can't be bombed. If an important objective is made to look unimportant, then it will be disregarded, overlooked, or neglected by an enemy. If a dummy target is placed in a logical site and attempts made to camouflage it, then the chances are the hostile observer will pick up this decoy, which attracts his attention, and will overlook the real target. So psychology has quite a bit to do with protective concealment, and the more we know about the psychology of the nations we are fighting, the better.

These basic principles have not changed for thousands of years, but methods have, especially in the last fifteen or eighteen years. Of course, complete practical concealment cannot always be used in the case of large industrial and other civilian establishments. It is, I believe, completely out of the question to conceal Manhattan Island, although some time ago a well-meaning individual suggested a plan according to which the entire island could be successfully concealed from prowling enemies: simply relocate the East River and the Hudson River!

The methods generally used in protective concealment of industrial establishments are: blending into surrounding landscape, reduction of visibility, distortion of structural shadows, and the placement of decoys in conjunction with the disguise of landmarks.

Sometimes an existing establishment can be blended into a surrounding landscape. The reduction of visibility can be accomplished by construction and also by the discriminate use of paint combined with texture and the study of shadows. The distortion of shadows can be carried out by changing the shape of the buildings by removing or adding superstructures and by dummy extensions.

Decoys in conjunction with the disguise of landmarks are sometimes very simple to execute. For instance, let us assume there is an important civilian establishment which in itself is rather hard to locate, especially after it has been concealed or treated; but there is a church in the vicinity with a tall, white steeple located near a crossroads—points of bearing for the gunner or bombardier. In such a case, the congregation of the church would have to be approached for permission to remove that steeple for the time being, and a dummy church—a motion-picture setting, so to say—would have to be set up somewhere several miles away so that a bombardier would be confused. As to the roads, dummy roads consisting of pieces of canvas stapled or pegged down in the fields could be used, while the actual ones would have to be colored and textured so as to blend into the surrounding terrain.

THE considerations to be remembered as to protective concealment of existing establishments are simple: The first is to consult with the local designated authority in charge of protective concealment. The second is to secure suitable aërial photographs of an establishment and surroundings. By surroundings I mean that oblique or panoramic pictures should be taken from 4 points of the compass at about 10 minutes' flying time, if a ship is used that does not fly any faster than about 80 or 100 miles an hour. If a ship is used that flies faster than 200 miles an hour, then the photographs should be taken at 5 minutes' flying time at an altitude of approximately 5,000 feet. In addition to that, vertical photographs in stereoscopic pairs should be taken. That means overlapping pictures should be taken of that particular factory at an altitude of about 4,000 feet. Of course, no bomber will dare to come down that low, but for the purpose of studying the problem at hand and preparing adequate protective concealment it is necessary to take pictures at low altitudes. Frequently it is found necessary to take single photographs at an altitude of about 1,500 feet because, in the majority of cases, stereoscopic overlapping pictures cannot be taken at so low an altitude. These photographs should be taken with panchromatic film, and, if possible, the pictures from lower altitudes should be taken in color, too.

The third consideration is the planning of installations by experts, approved by local authority. As yet, however, there are not very many experts! Another consideration suggests supervision and inspection of projects by means of aërial photographs and aërial inspection. This, too, is very important. I have seen repeatedly how protective concealment projects which started very auspiciously ultimately failed because progress had not been checked from the air. It takes years of experience to be able to visualize what things look like when seen from the air, and unless check-ups by means of aërial photographs are made during the progress of the project, some very bad mistakes are liable to be made which ultimately may nullify the entire effort. Hence, very frequent observations have to be made from the air.

Then there is the consideration of practicability. Costs must be held down as much as possible, so it should be known to what extent protection has to be provided. One of the first things to be considered is the study of the local shadow sector. Objects will cast shadows which have the same outline as the objects themselves, and an experienced reader of aërial photographs, by looking at the length of the shadows, will be able to tell the actual height of the object that cast the shadow as well as its shape.

The proportionate cost of installation has to be considered. If the cost of installing protective concealment almost approaches the value of the plant, then it certainly would not be advisable to do anything about it. I have come to the conclusion that the total amount to be expended on a project should not exceed ten per cent of the value of the actual objects to be concealed—not of the entire plant and not including real estate value, of course. If this maximum of ten per cent is observed, then, distributing it over five years, it will come down to approximately two per cent a year—which appears to be a reasonable figure. In Germany, I understand they allow up to twenty-five per cent of the value.

Then there is the time element involved. This has to be taken into consideration by the individual who does the planning and designing, hence simplicity of design and simplicity of maintenance are very important. Adaptation to seasonal changes is also important. It goes without saying that at least twice a year a change would have to be made—in the spring and fall.

The possible utilization in peace of those additional structures which have to be constructed to provide war-time protection should also be considered. In Germany, for example, where certain factories could not be put underground, the ground was graded up to the highest point of the building and the interior of the ramp thus created used for additional storage space. Thus, a clever designer of protective concealment not only can provide adequate protection from actual bombing, but he also can produce additional space which can be utilized in times of peace by the concern involved.

DISTORTION of form requires a special technique. By adding simple pieces of superstructure to a conventional building, it is possible to distort its form and also distort the shadow it will cast. Distortion by extension can be accomplished by adding temporary structures. If shadows are to be distorted, in many cases this can be accomplished by planting trees or by using trees that have been put into movable boxes. The Germans very successfully concealed air fields with dummy houses, small groups of woods, and groves which moved out of the way. In fact, it took the R.A.F. over a year to spot a certain airfield in Germany, and it probably never would have been discovered if by mistake the Germans hadn't tried to move the houses and trees while an R.A.F. photographer was sitting at the camera. As it was, a succession of photographs were taken which showed that the whole "village" had started to move!

Elimination of reflection plays a very important part in protective concealment. Reflectivity of window and skylight glass will have to be cut down. One method of accomplishing this is by the use of nonreflective glass. Ordinary glass can be made nonreflective by treating it with a solution of hydrofluoric acid in water—1 part fluoric acid with 200 parts of water. By merely washing this solution over the glass, a very thin film is produced which cuts down the reflectivity but does not interfere with the transparency.

The control of lighting is a matter of organization discipline—and that's all there is to it!

PROTECTIVE planting and landscaping are of great importance. Excellent protective concealment can be obtained by no other means than the use of protective planting. The selection of plant material is, of course, important. It would be absurd to put up a group of deciduous trees in a terrain where only evergreens are found, and vice versa. Plants can be colored by chemicals. For instance, in trying to conceal an airfield, which is quite a difficult job, in many cases very much can be done by the use of fertilizer or chemicals which will make certain plants grow in a different color. By spraying grass with certain chemicals, such as ferrosulphide and tannic acid, grass can be made to look almost bottle green and will therefore photograph differently.

Texturing may be accomplished by different types of planting. An airfield may be laid out in such a manner that it is divided into obliques, squares, or whatever fits into the surrounding pattern. Then in one section the grass is mowed from north to south; in the next section the grass is allowed to grow as high as it will; in the next, the lawnmower is run from east to west; in the fourth, honeysuckle is planted; on the fifth, the mowing method is used again. Thus, an airfield can be changed in such a manner that from the air it might resemble fields, or a real-estate development.

In the majority of cases, artificial work will reflect quite differently from natural plants and natural features; hence, human handiwork—buildings, roofs and walls, roads, fields, towns, airfields, runways—will have to be textured and colored in such a manner as to blend in with the surrounding terrain. Protective coloring is very important, but it is necessary to know what colors, paints, and other coatings should be used. The method in which these paints are to be applied is another matter, of course. There is so-called disruptive painting, which is used to break up regular outlines and make them look irregular. Then there is what is commonly called "dazzle painting," which is considered more or less obsolete, except in a very few cases; and shading and countershading in such a manner that the colors used will blend in and form air matches as well as photographic matches with the surrounding terrain—for color or shadows which may seem to match to the human eye will not necessarily match when viewed under aërial photography.

PROTECTIVE concealment also can be accomplished by means of smoke. Smoke is, of course, not new in the Army and Navy; they have been using smoke screens for years. White smoke is generally used, but to use white smoke for protective concealment, especially for industrial plants, is not advisable because it will draw the attention of the bomber and also will register on an aërial photograph. Smoke will disperse after a while, and it can be safely assumed that the only place it will be really dense is at the point of generation. Therefore, if a heavy cloud of white smoke were seen, it could be safely assumed that the target was close by. Based on this assumption, experiments have been conducted with colored smoke, and it is believed that if several kinds of colored smoke are used, an appropriate mixture can be obtained so that when viewed from the air, the target will be concealed. The smoke itself, however, will not be noticeable if it has the same colors that are found in the terrain over which it is floating.

Another important item, of course, is the concealment of features which concern communications. For instance, if a railroad runs alongside a factory, it is difficult to conceal. Conventional parking areas are a dead give-away, although much can be done by erecting structures over them. The Germans have been doing that very extensively. The German workingmen do not use cars as much as ours, but a German factory cannot be spotted by looking for siding communications or parking lots.

The matter of ordinary smoke, steam, and flames has to be taken care of. Some of the most difficult things to conceal are steam jets coming from factories, as well as gas, smoke, and the like, which can be spotted at an altitude of 35,000 feet! However, as mentioned before, by means of colored smoke some means of protection can be provided. Flames, of course, are another matter; they are very conspicuous, especially at night, and there is very little that can be done about it.

Of course, secrecy concerning activities connected with protective concealment is important as a safeguard against enemy agents or fifth columnists.

Protective concealment after a snowfall is a rather difficult thing, and it has plagued experts for a considerable time. The difficulty is in producing a covering which not only has the color of snow but also the same reflectivity. The usual whitewash and white oil paint, enamel paint, white sheets, and the like, are not satisfactory because, although they fool the eye when seen from the air, they show up gray on an aërial photograph. The reason is this: Snow has a crystalline structure; it is composed of tiny crystals which reflect light differently than white cloth or other white substances which do not have a crystalline structure. The use of ground glass in connection with plastic paints may help solve this problem.

It will be seen from these necessarily limited facts, that protective concealment has possibilities little realized in this country and even less put into practice. It is not a cure-all for enemy air raids, but when properly handled by qualified technicians it can do a great deal toward lessening the effectiveness of enemy bombardment and safeguarding the lives and property of American citizens.

ARMY ORDNANCE

Founded 1920

Published Bimonthly by
THE ARMY ORDNANCE ASSOCIATION
WASHINGTON, D. C.

Col. J. L. Walsh, Founder and Editor, 1920-1922
Brig. Gen. R. H. Somers, Editor, 1922-1925
Brig. Gen. R. L. Maxwell, Editor, 1925-1926
Col. C. R. Baxter, Editor, 1926-1929

Editor: Lieut. Col. L. A. Codd, Ord. Res.
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The views and statements expressed in the articles and advertisements in ARMY ORDNANCE *are those of the authors and advertisers only and do not represent official War Department policy.*

MARCH-APRIL, 1942

Month by Month

AS OUR ARMS PRODUCTION ATTAINS CONstantly higher levels, the vast military problems of supply and maintenance come to the fore with equally strident emphasis. For this simple fact is fundamental: All the ingenuity of military planning and executing the Victory Armament Program will come to naught if the supply of repair parts, the transportation and shipping of those supplies, as well as all the seemingly minor services of good housekeeping are not instantly at hand. Thus it is that supply and maintenance as military functions of our armies demand constant vision and acceleration if the total job of total armament is to bring total victory. A tank out of operation for want of the merest spare part, a gun not firing for want of a minute quantity of lubricant, or a round of ammunition not deliverable for want of a suitable container is worse than no weapon at all. As the production program grows, so the supply and maintenance program must keep pace with it.

Congressional appropriations which have been made available for military armament are being allocated by the Ordnance Department at the rate of $717.42 a second during an 8-hour work day. The Department has allocated an average of $20,661,695 a day over the last five weeks for which figures were available. This amounts to $2,582,711.87 an hour, assuming an 8-hour work day, or $43,045.20 a minute.

By allocation is meant the assignment, through letters of intent or contracts, for the purchase of ordnance matériel or for specialized plants and equipment to produce that matériel. This ordnance matériel includes ammunition, small arms, artillery, tanks, combat vehicles, devices for controlling the fire of artillery, and pyrotechnics for signaling purposes —a total of some 1,200 different items.

Since July 1, 1939, a total of $12,643,000,000 has been appropriated for the needs of the Ordnance Department. This includes Defense-Aid appropriations as well as appropriations for our own land forces. These appropriations are over $5,000,000,000 more than those available to the Ordnance Department during the entire period of our participation in the World War, when $7,628,132,468.33 was appropriated for the fiscal years of 1917, 1918, and 1919. This phenomenal Ordnance record has been made with the finest coöperation on all sides and with a minimum of criticism.

Some questions at the beginning of 1942—prior to the establishment of the War Production Board—arose as to the methods used by the Ordnance Department in utilizing the entire industrial facilities of the country to carry forward this program. From the beginning, the Department has advocated maximum use of existing industrial facilities. Criticism to the effect that the Department was not prepared to take advantage of all the country's industrial strength is not well founded. This criticism usually presupposed that there were throughout the country vast industrial resources not now figuring in Ordnance procurement plans. Criticism which indicates that fifty-five firms throughout the country have supply contracts for over seventy per cent of the defense effort, so far as the Ordnance Department is concerned, presupposes that the Department for some unstated reason has favored these firms while neglecting others.

The facts and figures show the true picture. For example, at the end of last year the number of supply contracts placed with the three largest ordnance contractors totaled slightly over one billion dollars. Of this amount, eighty-eight per cent represented supplies which will be produced on a cost-plus-fee basis in Government-owned plants over a period of years. These firms were selected for their particular knowledge and ability in the technical operations involved. In constructing these plants, the Ordnance Department has in no way duplicated facilities existing in private industry. The items of ordnance matériel being made in these plants are of such a highly technical nature they simply could not be made elsewhere. No plants already in existence could do this work. If the nation wanted the armament, it had to have the plants. The Ordnance Department was not unaware of the need of using every facility in existence, but it could not use facilities that were not in existence. It had to build those facilities for the manufacture of such items as gunpowder, TNT, ammonia, etc., and the money spent for them constitutes a large part of the entire sum authorized to provide ordnance manufacturing facilities.

Much of the remaining sum was spent in erecting facilities to supplement the work of private industry, which had limited ordnance manufacturing possibilities. It has never been seriously contended by any one that private industry possessed any magic whereby machine tools capable of making belt buckles might be used in making high-alloy steel shells, although some light machinery could be used to make component parts.

The Ordnance policy has always favored subcontracting; in fact, it is one of the most important features of Ordnance procurement. For example, during last November the Ord-

nance districts were inspecting production on 4,803 prime contracts while they were inspecting the imposing total of 28,781 subcontracts. Forty per cent of these prime contracts were for components of ammunition which, no matter how much one might like to subcontract them, simply cannot be obtained by this method. These figures, of course, do not include thousands of firms supplying standard commercial items "off the shelf" which are inspected in the plants of the prime contractors.

As all readers of this journal know, the present emergency did not catch the Ordnance team unprepared. Detailed plans were ready to meet the situation, and these plans have been put into action. They are being supervised and coördinated by civilian and military experts under the direction of the Under Secretary of War, who is the chief procurement officer of the Army. The operation of these plans rested on two bases: (1) The utilization of all the resources of the country available for the procurement of ordnance material; (2) The decentralization of ordnance procurement through the districts.

When these facts are understood by the people, they cannot reach any other conclusion but that the Ordnance Department has come to grips with its procurement problems in a manner best calculated to further our armament program.

With procurement and production in gear and greater things to come in the way of mass manufacture of weapons, the problems connected with the supply and maintenance of weapons in the hands of troops loom larger and larger on the horizon. Fortunately, the Ordnance Department is well equipped to handle this great task. From now on, equal emphasis must be placed on the men and the organizations in the field who are hard at work to make certain that our guns are kept firing, our tanks moving, and our bombs dropping as, when, and where needed.

THE ARMY INDUSTRIAL COLLEGE, A UNIQUE institution in the annals of national defense, closed its doors "for the duration" when the last class was graduated December 23, 1941. The college had been in existence nearly eighteen years and had given a remarkable example of industrial-mobilization planning, the like of which has not been seen anywhere in our Army or in any other. Decision to close the college was reached with great reluctance and only because of the greater need for experienced procurement personnel in the field.

Since its establishment on a modest scale February 25, 1924, under authority of the National Defense Act, for the education of Army, Navy, and Marine Corps officers in the field of procurement planning and industrial mobilization, 1,191 officers have been graduated. Under the National Defense Act, as amended by Congress in 1920, the then Assistant Secretary of War, Dwight F. Davis, was charged with the "supervision of the procurement of all military supplies and other business of the War Department pertaining thereto and the assurance of adequate provision for the mobilization of material and industrial organizations essential to wartime need. . ." It was to assure "adequate provision" that the school was founded.

The first class included only nine Regular Army officers, from supply branches, and was graduated after completing a 5½ months' course. Later, the course was extended to cover nine months and the number of students increased steadily until the class which graduated July 3, 1941, numbered eighty-seven officers. The students were detailed from the Regular Army, Navy, and Marine Corps in the early days of the college, but in later years, Reserve officers of the three services were included. Because of the mounting emergency, these later classes pursued the "short course" of three months, including, however, all phases of the longer courses.

The function of the college was best expressed some years ago in an address to the student body by Col. Frank A. Scott of Cleveland. Renowned student of military affairs, Colonel Scott was the pioneer in the industrial mobilization of the United States in the World War. He said: "We must keep ourselves free to utilize such resources as are available at a given time, even if they do not come up to or within our prewar program. A rigid program in preparedness and procurement is justified only for a nation that has in prospect an aggressive war policy that can determine when the psychological moment has arrived to declare war. When the program has to be fitted into conditions that are controlled by outside circumstances it must be flexible, and, on that account, our programs can never avoid a period of improvisation. In this respect, our nation and England bear close resemblance at the beginning of any major war.

"Most fortunately for our country we continue to develop new men. And this brings me to my conclusion: You are of the group to whom we now look confidently for discerning leadership. Modern war calls for the use of the entire resources of the nation. Nothing, therefore, in our national economy can be without interest for you. We may pray that our country may never again be subjected to the trials and sorrows of war, and we may include a petition that, should war come, we, or those whom we have taught, may lead with courage, clear vision, and the firm belief that if we exert our strength we shall maintain our cause."

The curriculum offered training for the supply branches of the services similar to that offered on the command side by the Army War College. It trained men to prepare plans for industrial mobilization and war procurement, and to execute these plans in a manner which already has proved of tremendous value in the United States war effort. Research was conducted constantly into the complex problems of supply, and the students were encouraged to develop new ideas.

But there is much more to the actual founding of the Industrial College than is included in the formal record above. The idea and the first steps looking toward the college are attributable to the work of Ordnance officers, and now that the college is inactive for the duration is as good a time as any to present the record. This, ARMY ORDNANCE will do in its next issue.

THE *ORDNANCE SERGEANT*, PUBLISHED BY THE Ordnance School at the Ordnance Training Center, Aberdeen Proving Ground, is observing its first anniversary. Within a year, this most attractive and informative journal has won for itself high place among the technical publications on ordnance. It is entitled to the highest commendation for the excellence of its discussions, the authenticity of its views, and the caliber of its presentation. ARMY ORDNANCE extends its congratulations to the *Ordnance Sergeant* and wishes it well for the big job ahead. Ordnance texts on what makes the machine go are far too few even in times of great emergency. The value of the *Ordnance Sergeant* grows daily.

MacArthur

An Editorial

THE Battle of Bataan Peninsula is still under way as these lines are written. It began January 17th when the Japanese launched a heavy attack against the right flank of General Douglas MacArthur's American and Philippine forces on the peninsula. The defenders held off all Japanese thrusts and in several sharp skirmishes reëstablished their earlier position. Two days later, Japanese attacks were resumed in greater force and the defenders gave ground, but on the following day the American and Philippine troops reëstablished lines which had been penetrated. Throughout this engagement, enemy losses were described as heavy and American bombers blasted at airdromes and hostile vessels at sea.

During the next three days the fighting became increasingly severe, with hard-pressed American and Philippine troops striking back with fury. On the seventh day, fresh Japanese troops launched a series of heavy attacks on the left flank of the defenders' line. These attacks were supported by fire of hostile naval vessels and aircraft. General MacArthur's position became critical. From then until this writing the fighting has increased in severity daily.

This battle, the first in which American stamina has shown itself in a campaign in this war, has reintroduced to the American people a great soldier whose influence on our national defense during the past three decades now becomes the most paradoxical in our military annals. This man, great tactician and fearless soldier, is now suffering the effects of weak military peace-time policy which he himself begged an unheeding people to correct. This he did unceasingly when there was ample time for remedy. But his counsel and pleadings were disregarded in a day when pacifism was rampant and herculean effort was required to save our pitiful army from all but annihilation by our own people.

THE proof of this indictment can be garnered from General MacArthur's own pen in the pages of this very magazine. Writing in ARMY ORDNANCE just a little more than ten years ago, General MacArthur gave this timely warning in presenting the first Industrial Mobilization Plan. His words are taken from the September-October 1931 issue of this journal (Vol. XII, No. 68, p. 83).

Note the plea for peace: "As a practical step, then, in the *promotion* of peace, the War Department strives to assist in impressing upon *our own people* the serious and terrible nature of modern war, and the obligation devolving upon every citizen and upon every resource to participate equitably in carrying the burdens it imposes. A widespread knowledge of these fundamental truths, backed by a program to insure a proper distribution of war's burdens, cannot fail to have a sobering influence upon any group tempted from selfish motives to urge the adoption of national policies that might eventually result in international conflict."

But then the call to preparedness: "However, even a fixed desire of our own people to avoid war does not eliminate the possibility of external aggression. The Department holds to the belief, so often reiterated by our first President, that *a reasonable preparation for defense is one of the best guarantees of peace*, because of its deterring effect upon any government that might contemplate attacking us. The soundness of this belief has been demonstrated more than once in our history, both affirmatively, when we were unusually well prepared to exert promptly a strong military pressure, and negatively, when we were relatively weak in this respect."

And finally the duty to defend: "The War Department has the task, under the authority of Congress, of building up a defensive structure that will make hostile attack improbable. It has also the duty of making all preparation, permitted under current congressional policy, that will, in the event of attack, contribute to the defeat of the enemy and to the elimination of those preventable evils that have made their appearance in all past wars."

AGAIN in these same columns (ARMY ORDNANCE, January-February 1933, Vol. XIII, No. 76, p. 200), he concluded an analysis of technical and scientific armament developments under way at that time: "In the aggregate," General MacArthur wrote, "there are hundreds of items in which our technical experts are developing models, the most efficient of their kind. These items vary in character from the delicate radio instruments for communication between fast-moving combat vehicles to heavy seacoast guns for harbor defense. The Army's intense interest in these projects is not occasioned by a belief that any machine or weapon in itself is or can be the dominant factor in war. That factor is man himself. It is men who declare war, and it is men who must uphold on the battlefield the decision the nation has made. Armed conflict, which occurs when all other means of adjusting vital international differences have failed, continues until the determination of one contestant to carry on the struggle has been overcome."

General MacArthur continued: "The power that men exert in battle may be represented as the algebraic sum of a variety of elements, among which are leadership, numerical strength, morale, organization, mobility, logistic arrangements, individual skill and training, and the quality and quantity of weapons and equipment. Before engaging in decisive action, each side makes every effort to be stronger in all these elements than is the other. If either opponent enjoys overwhelming superiority in any one of them and approximate equality in all the others, it will almost certainly be successful. Thus a tremendous and even decisive superiority may accrue to an army if its enemy has failed to recognize and to exploit the advantages offered by scientific achievements. It is, therefore, one of the fundamental responsibilities of peace-time military establishments to develop the utmost efficiency in weapons as well as in all other elements of combat power."

The irony of all this is that the man who, not ten short years ago, begged for a proper recognition of industrial preparedness and adequate arms, today is bearing the brunt of our national neglect of his own warnings. All the more reason that our twofold purpose be prosecuted with intensified effort: (1) This war must be won completely and fully with the weapons we are now feverishly building but which we denied to General MacArthur ten years ago; (2) General MacArthur and his heroic fighters at Bataan are proof that our foreign policy and our military strength hereafter must stand as one. The days of big talk supported on a reed shaken by the wind are over—if we are true to MacArthur and all the name stands for.

L. A. C.

Association Affairs

ASSOCIATION PROGRESS, 1941

THE annual meeting of the trustees and directors of the Association was held in New York City at the University Club on February 17, 1942. Inasmuch as this issue of ARMY ORDNANCE went to press before the meeting, a complete report of the transactions will be published in the next issue.

At the meeting, the annual report of the executive secretary was submitted. It described the activities and affairs of the Association for the calendar year ended December 31, 1941. Extracts from the report follow:

The last previous report for the calendar year ended December 31, 1940, was submitted to the trustees and directors and approved at their last annual meeting held in the city of New York on the 14th day of February, 1941. General statistics for the year 1941 were: A net gain in membership of 3,301 (as compared with a net gain of 2,609 for 1940); gross receipts, exclusive of contributions to the Ordnance Endowment Fund, were $115,246.03 (in 1940 they were $73,644.44); gross expenditures were $95,485.37 (in 1940 they were $60,505.69). The excess of operating receipts over operating disbursements was $19,760.66 (in the preceding year there was a net gain of $13,138.75).

Membership: The total membership of the Association in good standing as of January 1, 1941, was 7,292. During the year, 3,927 new members (1940: 2,999) were enrolled while 626 (1940: 390) old members were removed from the roster through resignation, death, and nonpayment of dues. The number of members in arrears was 626 (1940: 443), of whom 34 (1940: 31) were in arrears for more than six months. The membership at the end of the year was 10,593.

During the year, 105 new group members were enrolled and 5 were dropped; there were 321 group members in good standing at the end of the year.

Local Posts: During the year two new local Posts were established: One, the University of Michigan Post (membership 66), February 20th; the other, the Hartford-Springfield Post (membership 680), November 18th, with headquarters at Springfield, Mass. There are now eighteen chartered posts.

Financial: The excess of cash receipts over cash expenditures for the year, with all bills in hand paid, was $19,760.66.

A financial statement of income and expenditures for the year is shown in Table 1. A statement of resources and liabilities appears in Table 2.

Audit: The accounts of the Association for the year 1941 were audited by Messrs. Ernst & Ernst, certified public accountants. The audit is as of December 31, 1941; the last previous audit was made by the same firm of accountants as of December 31, 1940.

Office Staff: The office staff consists of eight salaried employees: executive vice-president, assistant secretary, associate editor, secretary for membership, assistant secretary for membership, editorial assistant, and two clerical assistants.

Fidelity bonds for employees charged with financial responsibilities were in effect during the year. Group hospitalization insurance for all salaried employees, for which premiums are paid by the Association, was begun in 1937 and has been continued.

Annual Meeting: The Twenty-Second Annual Meeting of the Association was held in Detroit October 9, 1941, at the Book-Cadillac Hotel and at the Chrysler Tank Arsenal.

The morning session, devoted to ordnance production, had an attendance of about 600. Nearly 1,000 were in attendance for the Industrial Mobilization Luncheon and approximately that many members and guests visited the Chrysler Tank Arsenal. For the Twenty-Second Annual Dinner, covers were set for 1,220 and approximately 350 were turned away. The gross receipts from the meeting were $9,435.50. The gross expenditures were $9,362.49.

Other Meetings: Throughout the year, many local and regional meetings were held under the auspices of the various local Posts and of engineering and industrial societies. Officers of the Ordnance Department, especially the Chief of Ordnance, addressed many of these gatherings. Following the practice of recent years, the executive vice-president accepted, wherever possible, invitations to address national-defense groups throughout the country. These included technical and engineering societies, military organizations, schools and colleges. Such of these gatherings as were under the auspices of the Army Ordnance Association were fully described in ARMY ORDNANCE throughout the year.

The Ordnance Endowment: Pursuant to the action of the Board of Directors at their last annual meeting, an Endowment Committee was organized under the chairmanship of Mr. T. M. Girdler of Cleveland. The committee began its active solicitations in September, and by year's end cash contributions to the fund totaled $159,375. It proposes to continue its activities throughout

INCOME AND EXPENDITURES, 1941

Income

Old members	$ 37,552.19
New members	21,135.55
Interest	1,014.27
Old subscriptions	2,509.14
New subscriptions	3,485.44
Advertising	36,822.56
Annual Meeting	9,435.50
Miscellaneous	3,291.38
Life members	0.00
Total	$115,246.03

Expenditures

Rent	$ 2,225.00
Office expense	6,762.49
Salaries	19,938.54
Postage	2,394.40
Annual Meeting	9,362.49
Office equipment	3,030.14
Extension	1,298.51
Post refunds	2,922.94
Contingencies	2,196.55
ARMY ORDNANCE	39,388.42
Annuities, insurance and bonding	2,064.06
Bulletin	3,319.46
Endowment Committee	582.37
Total	$ 95,385.37

TABLE 1. INCOME AND EXPENDITURES FOR 1941

BALANCE SHEET, DECEMBER 31, 1941

Assets

Cash on hand	$ 40.00
Cash on deposit	35,960.07
Accounts receivable:	
Due from advertisers	1,030.50
Other assets:	
Securities owned	24,557.82
Postage	1,032.15
Ordnance Endowment Fund	159,375.00
Furniture and fixtures	1.00
Deferred charges:	
Commission on prepaid advertising	251.68
Total	$222,248.22

Liabilities

Unearned income:	
Prepaid membership dues	$ 31,456.61
Prepaid subscriptions	2,496.70
Prepaid advertising	695.40
Salary payable	0.00
Reserves:	
Ordnance Endowment Fund	159,375.00
Spruance Endowment Fund	822.50
Life memberships	2,100.00
Operating reserve	25,302.01
Total	$222,248.22

TABLE 2. BALANCE SHEET AS OF DECEMBER 31, 1941

the year 1942 in the hope of obtaining a fund of $500,000. Under date of December 12, 1941, with the approval of the Board of Trustees, the president executed a trust agreement with the American Security & Trust Company of Washington whereby the company became trustee for the Ordnance Endowment. All funds for this purpose as received are transmitted to the trustee for investment and administration.

MILWAUKEE POST

THE annual election of officers of the Milwaukee Post, Army Ordnance Association, was held Friday, January 30th. The following officers were elected: president: W. W. Coleman; vice-president: J. E. DeLong; directors: Max Babb, F. R. Bacon, D. P. Davies, Harold Falk, R. S. Hoar, H. Stanley Johnson, Herbert V. Kohler, Robert A. Uihlein, Pierpont J. E. Wood. F. O. Wyse was elected secretary-treasurer. Mr. Wyse succeeds C. W. Laumann who has served as secretary-treasurer of the Post for a number of years. The Army Ordnance Association is much indebted to Mr. Laumann for his faithful and energetic service to the local chapter since its formation fourteen years ago.

ST. LOUIS POST

THE following roster of officers of the St. Louis Post recently has been elected and inducted for the current term: president: Edwin B. Meissner; vice-president: Robert A. Bagnell; directors: Harry Scullin, Spencer Olin, P. J. Watson, Jr., Willard R. Cox, Ben Comfort, H. B. Deal, W. M. Akin, W. Stuart Symington; secretary-treasurer: Randall J. Hogan.

PITTSBURGH POST

COL. JAMES L. GUION has been elected a vice-president of the Pittsburgh Post. Col. G. Elkins Knable, who is now on active duty in the Office of the Chief of Ordnance in Washington, has been succeeded as treasurer by Maj. Thomas Eddy who also succeeds to the secretaryship. Major Eddy has been an active participant in the affairs of the Pittsburgh Post for many years and his accession to this office is welcomed by his many friends throughout the Ordnance organization. The complete roster of executives of the Pittsburgh Post for the current year follows: president: Herbert A. Gidney; vice-presidents: C. W. Heppenstall, James L. Guion; directors: Frank B. Bell, G. M. Sixsmith, S. L. Goodale, F. A. Merrick, W. F. Detwiler, J. D. Berg; secretary-treasurer: Thomas H. Eddy.

ASSOCIATION MEMBERSHIP

IN response to many inquiries regarding the various types of membership in the Army Ordnance Association, the following extracts from its constitution and by-laws are published. The objectives of the Army Ordnance Association are:

(1) To assist in effecting industrial preparedness for war as being one of the nation's strongest guaranties of peace;

(2) To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

(3) To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve officers of the Army Ordnance Department;

(4) To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

(5) To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

(6) To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

In the accomplishment of these objects the Association shall have all the powers set forth in the certificate of incorporation and granted to it by Subchapter III, Chapter XVIII, of the Code of Laws of the District of Columbia.

Full membership in the Association shall be open to all men who are American citizens and who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of ordnance material.

Life membership in the Association shall be open to all men who are American citizens and who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of ordnance material. Life membership shall continue during the lifetime of the life member and shall expire at death. It shall not be transferable.

Student membership in the Association shall be open to all men who are American citizens and who are students in technical schools or colleges. Student members shall not vote or hold office in the Association.

Group membership in the Association shall be open to all individuals, firms, companies, and groups controlled by American citizens who are interested in promoting the cause of industrial preparedness particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of ordnance material.

Group members shall have the privilege of nominating ten men for full membership in the Association, and members thus nominated shall pay no dues.

Honorary membership for life shall be conferred, in the discretion of the board of trustees, upon persons who have rendered meritorious service to the cause of industrial preparedness. Honorary members shall be entitled to all privileges of full membership except as otherwise provided in this constitution and in the by-laws.

The government of the Association shall be vested in its officers, a board of directors and a board of trustees.

The officers shall consist of a president, a first vice-president, and a second vice-president, who shall be elected by letter ballot of the members of the Association for a term of two calendar years, and a counsel, a treasurer, and an executive secretary who shall be elected by the board of trustees, and who shall hold office for two calendar years or until their successors have been elected and qualified.

The board of directors shall consist of the president, who shall be *ex-officio* chairman, the vice-presidents, one member elected by each duly authorized Post of the Association, and six members elected by general ballot of the members of the Association. The term of office of members of the board of directors elected by letter ballot of the Association shall be for four calendar years, provided that the term of three members thereof shall terminate December 31, 1930, and every four years thereafter, and of the remaining three December 31, 1932, and every four years thereafter. The board of directors shall have the power to fill casual vacancies in the case of its members elected by general ballot and in the offices of president and vice-president.

The board of trustees shall consist of the officers and one director to be appointed annually by the board of directors and shall act as the board of trustees required by the laws of the District of Columbia to have control and management of the affairs and funds of the Association. The board of directors shall prepare by-laws governing the Association which shall become effective when approved by a majority thereof.

Ordnance in Review

THE MACHINE GUN—ITS EARLY APPLICATIONS, PART IV

LIEUT. COL. CALVIN GODDARD

J. F. OWEN'S reference to the Claxton gun ("Mitrailleurs or Machine Guns," 1874) is limited to the brief statement that in 1868 a rifle battery invented by "Colonel Claxton" was submitted for trial before British military authorities and that it consisted of eight, ten, or twenty barrels, to be fired in pairs. "It did not appear so good an arm as the Montigny." Génova indicates that it, like the Gatling, had a tryout in the American Civil War, thus: "Otros sistemas, el Claxton y el Gatling entre ellos, fueron empleados algunas veces con éxito sufficiente para despertar la emulacion entre les inventores." Hatcher, Wilhelm, and Maloney make no mention of the Claxton, while Longstaff and Atteridge reprint Owen's remarks as outlined above. Farrow does not refer to it in his voluminous encyclopædia (1885), so it may be assumed to have enjoyed but brief existence. Its designer, despite Fosbery's statement, does *not* appear to have been an American.

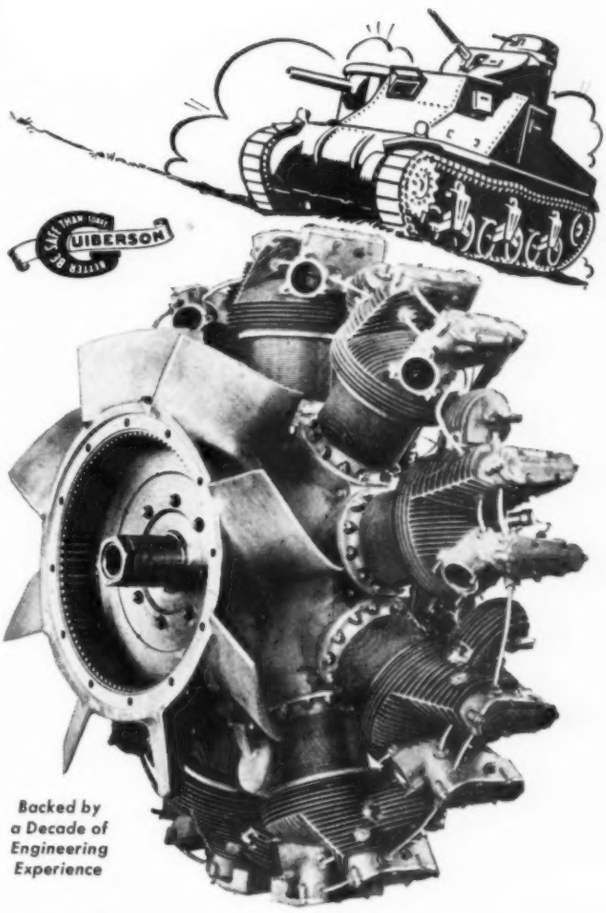
J. E. Hicks' rather vague reference to "Union repeating guns, pieces consisting of two rifled barrels which operated in front of a breech mechanism," would appear to point definitely to the Claxton, the only Civil War weapon fitting this description. But when he goes on to say that "President Lincoln nicknamed them 'coffee mills,'" we are left in a state of high confusion, since the "coffee mill" or "coffee grinder" applies, according to such other sources as we have consulted, specifically to the Ager piece. However, since both the Claxton and Ager were, like the contemporary coffee mill, crank-operated, it is readily possible that the unflattering nickname may have attached to both—and even perhaps to the crank-actuated Gatling as well.

Before we enter more fully upon Gatling's European adventures and upon descriptions of the types of weapons with which he found himself in competition overseas it may be well to complete our brief discussions of machine guns figuring in the American Civil War. We have learned that the Gatling most definitely played a part, if a minor one, in that affair, and have noted Fosbery's statement that he believes the Ager to have been employed "for the defense of bridges and narrow passages." And we have just recorded the statement of Génova as to the participation of the Claxton in the 5-year struggle, together with the supporting quotation from Hicks. We read in Hatcher, Wilhelm, and Maloney that the Billinghurst and Requa piece "was used in the late stages of the American Civil War"—this brief remark remaining unamplified. But we do find amplification in the work of a British artillery officer, C. H. Owen, who tells us that:

"A kind of mitrailleuse was used at the siege of Charleston, called a 'Requa rifle battery.' It consists of twenty-five rifle barrels, each twenty-four inches long, arranged horizontally and held in position upon a light field carriage by an iron frame. Upon this frame, in the rear of the barrels, is fitted a sliding bar working by two levers (one at each side), by which the cartridges are forced to the rear of the chambers. By a lever under the frame the barrels may be diverged so as to scatter the balls [over a front of] 120 yards at a distance of 1,000 yards. The weight of the battery complete is 1,382 pounds . . . When served by three men, the battery is readily fired seven volleys, or 175 shots, per minute; 1,300 yards is probably the effective range." (See also Génova for a statement closely similar.)

Another extremely interesting machine gun of Civil War vintage, the first we have come upon as of Confederate origin, is to be found in the same collection. Its design is ascribed to Maj. Gen. Josiah Gorgas, father of Maj. Gen. W. C. Gorgas of Panama Canal fame. The catalogue description of this reads:

Radial Air Cooled Diesel Engine



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POWER for the knock-out punch—that is the hard-hitting, longer range, more economical Guiberson Air-Cooled Radial Diesel engine. To produce the maximum number of these up-to-the-minute tank engines at the fastest possible rate—that is the pledge of the Guiberson Diesel Engine Company to the armed forces of this country.

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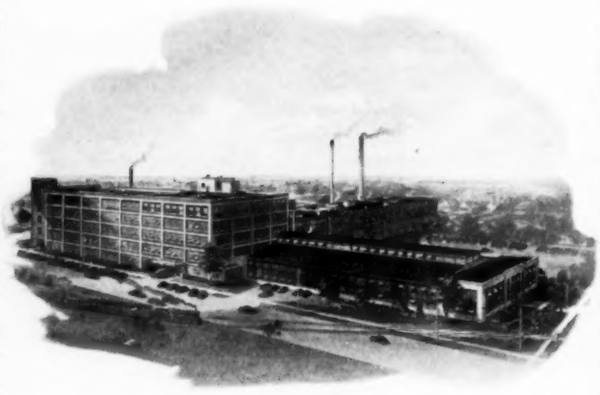
Our Pledge

King-Seeley Corporation is actively engaged in producing material for the three major services—Army, Navy and Air Corps.

This expression of confidence in our ability to do the job is accepted with a full appreciation of the responsibility which it places upon us.

We hereby pledge ourselves to an "All-Out" effort—to the end that our Armed Forces may be fully equipped to attain their ultimate goal of Victory.



KING • SEELEY CORPORATION

ANN ARBOR, MICHIGAN

"Gorgas Confederate cast-iron smoothbore rapid-fire gun, cal. 1.25 inches. Invented by Gen. Josiah Gorgas . . . Chief of Ordnance of the Confederacy . . . Captured during the Civil War. This is a machine gun employing a single barrel, and an annular ring of eighteen copper-lined, muzzle-loading chambers on its outer circumference. Corresponding percussion-cap nipples on the inner circumference provide means by which the charges are fired when in proper position. The gun is provided with a pintle on which it can be moved in azimuth."

Unfortunately, there is nothing to indicate that Gorgas' device ever went into production, or that the specimen described above, or any other like it, was aimed or fired at hostile forces. Nor can we say with assurance that the piece we are about to discuss ever took part in a clash of arms, though it would appear not improbable that it or its counterpart (now located at Petersburg, Va., and erroneously described in Part I of this paper as having figured in the siege of that city) saw some active service. For both of these happen to be examples of the Vandenburgh system as produced for the Confederacy by the British firm of Robinson and Cottam. The piece at the Military Academy is of the same caliber (.50) as the one at Petersburg, but exhibits only 85 barrels as against the 121 possessed by the latter (illustrations of which appear in Part I of this series). Its catalogue description reads:

"Vandenberg Volley Gun, cal. .50 . . . Captured by the cavalry forces under Maj. Gen. Geo. Stoneman, U.S.C., at Salisbury, N. C., April, 1865. The people of North Carolina called this gun, 'Governor Vance's Plaything.' It consists of eighty-five barrels grouped in a cylindrical casing of bronze. The breech piece, with eighty-five muzzle-loading cartridge chambers, fits in the barrel casing. The breech piece is swung in position by a hinge and screwed to the casing. All barrels are fired simultaneously by a percussion cap. After firing, the breech piece was unscrewed, pulled out, and swung down to loading position."

Vandenburgh (the spelling in the catalogue description just quoted is apparently incorrect) appears to have been at once a mystery man and a reversed likeness of Dr. Gatling. For whereas Gatling favored the South but sold guns to the North, Vandenburgh, whose guns were produced in England for Southern consumption, presumably espoused the Federal cause, since we have some reason to believe that during or prior to 1862 he held a general's commission in the New York Militia. Prior to that year his existence seems to have been unknown to all save his immediate acquaintances, but in 1862 he popped up in London to deliver a lecture to the membership of the Royal United Service Institution. There he was introduced as General Vandenburgh of the New York State Militia—or at least the printed account of the proceedings on that occasion place the letters "N.Y.S.M." after his name. Yet he does not appear in the "Official Records" of our Civil War, and a careful search of its archives which the Adjutant General's Office of the State of New York was kind enough to make recently at my request yielded no information upon the gentleman.

The title of his London discourse, which occupies some thirteen pages of the printed volume in which it appears, is, "A New System of Artillery for Projecting a Group or Cluster of Shot" (London, 1862). A large portion of his address is given to comparisons between the effectiveness against personnel of certain field-artillery pieces of his day and his own invention—all, needless to say, favorable to the latter. He proposed to make his gun in two calibers, .451 and .577, the second corresponding to the bore of the Enfield then standard with the British. The projectile for the smaller was to weigh 530 grains; for the larger, 2 ounces. Each type was to be made in several sizes. Thus the caliber .451 would embody 85, 151, 163, 211, 265, or 451 barrels in parallel bundles, like so many toothpicks, the internal diameters of their encompassing jackets varying from 7 inches for the 85-barrel type, to 15⅝ inches for that with 451 tubes. In the .577 bore, he proposed to use from 85 to 211 barrels, internal jacket diameters varying from 10.62 inches to 26.37 inches—a substantial figure for any man's machine gun. (*To be continued.*)

Professional Digest

SERVICE AND MAINTENANCE OF MILITARY TIRES

G. M. SPROULS*

A RECENT inspection by trained personnel of some 3,600 discarded tires from military vehicles showed the following: 2 per cent were returned to service without any conditioning; 20 per cent were repaired; 19 per cent were recapped; 59 per cent were classified as not worth repairing or recapping.

This was before we were actually engaged in war. The urgency for tires and still more tires, with the present difficulty of importing crude rubber from the Far East, might warrant a reinspection of all scrap tire piles. Tires which on a strictly cost basis might not have warranted repairing or recapping might now be reclassified if reinspected in line with present-day conditions. Any such inspection should be made by men specially trained for such work.

A large number of the tires inspected showed but a slight amount of wear. This would mean that the two per cent (seventy-two tires) which were returned to service without any conditioning would give almost the same service as a new tire.

In commercial operations, where repairs are not made until much later in the life of the tire than would be the case here, about equal mileage was obtained after the repair as before. Relatively few repaired tires failed at the repair. Actual records of a typical large commercial fleet indicate that the average mileage of repaired tires was slightly higher than the average of all tires, actually 1½ per cent. Mileage after repair was fifty-six per cent of total miles on the repaired tires. Twenty-seven per cent of the total tires were subjected to repairs. This is the result of several hundred repaired tires so it should be given considerable weight. The 20 per cent (720 tires) repaired, provided they were properly repaired, should give at least as good results as on this commercial fleet.

Only a slightly less percentage, nineteen per cent, were recapped. A good recap should give satisfactory service—not as much mileage as should be expected from a new tire, but more than enough to cover the cost of recapping. Just how much mileage is obtained depends on the type of service in which the tire is used. In commercial service, mileages of from sixty to ninety per cent of new tire mileages have been reported. At the present time, however, the major gain in recapping is the conservation of crude rubber. Where the carcass or body of the tire is sound, the rubber in the carcass sidewall should be conserved by applying additional wearable tread rubber by recapping or retreading. The amount of wear and condition of tread area should determine whether a recap or retread should be made.

As stated above, fifty-nine per cent of the tires inspected were classified as not worth repairing or recapping. Why were so many tires in such a condition? The tires themselves tell the reason. The scrap pile is the best place to learn how tires have been used on a fleet of vehicles—whether they have been properly maintained and serviced. Observations during a number of the recent Army maneuvers and inspection of scrap piles at a number of Army camps have brought out certain pertinent facts.

Consider the fact that the failure of a tire will hold up a modern military vehicle just the same as the failure of any other vital part. In commercial service, road delays have been reduced less than one-tenth of what they were before properly supervised maintenance and service were installed. Considerable reduction of delays due to tires on military vehicles should be made by similar methods.

*Manager, Highway Transportation Department, Goodyear Tire & Rubber Company, Akron, Ohio. Formerly, Major, Ordnance Reserve, U. S. Army.

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The seamless process is particularly adapted to the production of heavy walled tubing, various types of cylinders, and tubular forgings in a wide range, especially where upsetting, swaging, spinning, or bending operations are to be performed and where a clean, smooth bore or surface finish is highly important. Either as NATIONAL Seamless Pipe or as Shelby Seamless Mechanical Tubing, the identifying emblem, "Walls Without Welds," means—America's Preferred Pipe and Tubes.

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UNITED STATES STEEL

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An Army on Wheels

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BALL AND ROLLER BEARINGS

● This new Trackless Tank has mobility . . . is capable of high speeds.

The old saying, "An army travels on its stomach," should now be changed to "An army travels on rubber." It is said that nearly one out of every three men in the U. S. Army is called upon to drive a truck or its equivalent—and by equivalent is meant anything from a ¼-ton "jeep" to a 40,000-pound tractor-trailer transport. The mobility of the Army can be seriously reduced if tires are not properly maintained.

The importance of tire maintenance has increased considerably since Japan declared war on us. Now it is not merely a question of maintenance to insure efficient operation of equipment—although this is still essential—but with the possibility of greatly reduced imports of crude rubber from the Far East, it is imperative that there be no waste of rubber due to lack of proper care of tires.

THE following recommendations are made based on experience gained in supervising the service of over 27,000,000,000 tire miles in civilian service. We feel confident that if followed, they will result not only in increasing the life of tires but also in reducing delays due to tire failures.

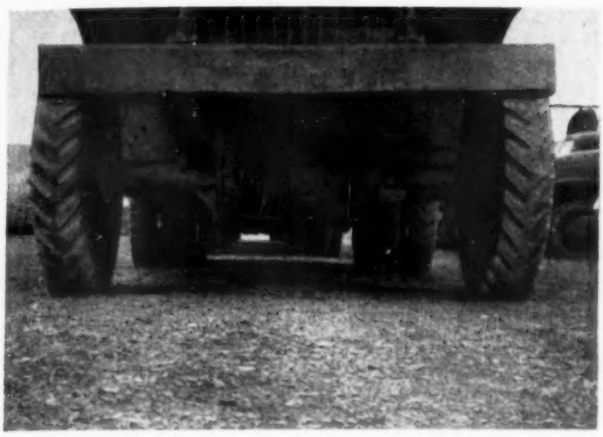
DIRECTIONAL TIRES PROPERLY MOUNTED ON THE FRONT WHEELS OF A MILITARY VEHICLE

A majority of the men handling Army and Navy motorized equipment have driven their own personal cars, yet, in spite of this fact, few appreciate the importance which should be given to the maintenance of proper inflation pressure in tires. The ease and low cost of replacement of passenger-car tires in the past has more or less nullified the importance of proper inflation pressure. In commercial operations, both trucking and bus operations, where tire miles mean dollars, considerable attention is given to the maintenance of proper inflation pressure; where the daily vehicle mileage is relatively low, inflation checks are generally made twice a week. On long-distance hauls, checks are made before every trip. Such checks should be made a standard routine at specific periods, and the responsibility for them should be given to certain men. Only by such frequent checks will drops in pressure be observed. Otherwise, not only premature failures but reduction in final tire mileage may be expected.

Overinflation increases the probability of bruising and cutting due to placing the tread and carcass under greater tension. In case of overload, a maximum of ten pounds over standard inflation is recommended. It may be asked why maintenance of proper inflation is so essential. It is the air that really carries the load. A conventional tire without air would not carry much load. The function of a tire is for the carcass or fabric portion to act as an air container, in conjunction with the tube, and for the rubber tread to provide traction and material to take the wear. Tires are designed to give their maximum service when subjected to a definite per cent of deflection under load. Excessive deflection generates additional heat and may cause separation between plies and fabric fatigue.

Equipment used by our armed forces has been carefully designed, and special attention has been given to load distribution and specification of the proper size of tire for that load. Not to maintain proper inflation pressures would nullify the advantage of good engineering. The size of tire and the proper inflation pressure for the load it is subjected to should be readily available to those whose duty it is to maintain inflation pressure. Stenciling or painting of the tire size and its recommended inflation pressure on each vehicle should be of help. The use of valve caps on valve stems not only provides a double air seal, but also prevents foreign material from reaching the valve core. This is of great importance when equipment is passing through muddy or sandy sections.

Needless to say, the spare tires carried on vehicles should be checked as frequently as tires on rolling wheels, otherwise the spare might be useless when needed. Spares carried on vehicles, especially those exposed to the elements, should be included in a pool of the tires on running wheels. In this manner, the injurious



IMPROPER MOUNTING OF DIRECTIONAL TIRES FOR FRONT WHEELS BUT CORRECT FOR REAR

effects due to exposure will be reduced considerably. Spare tires should be stored in a dark, cool, place if possible and should be kept free of oil and grease. Rubber quickly deteriorates in the presence of either oil or grease.

NO condition will cause faster tread wear than excessive "toe-in" or "toe-out." Front tires on a vehicle are said to have zero toe-in when they are parallel in a vertical plane. If the two tires are closer together in front of the axle than at the rear, they are said to be "toed-in." If they spread out, being farther apart in front than at the rear of the axle, they are said to be "toed-out." New tires have been worn completely through the tread to breaker in a few hundred miles with excessive toe-in or toe-out. This type of misalignment usually is the result of a severe bump which bends the tie-rod or the steering arm. If the amount of excessive toe-in is less than ¼-inch, correction may be made by adjustment of tie-rod; if more than ¼-inch, then the bent part should either be put into its normal condition or replaced. Best wear will be obtained when toe-in is not more than ⅛-inch. No toe-out should be permitted.

The type of tire used on a majority of Army vehicles is of the "mud-and-snow" type. The tread design may be "directional" or "nondirectional." With the directional type, it is desirable for the best service and wear to mount the tires so that they will rotate in the proper direction. This differs depending on whether they are on the front or rear wheels. The proper position on front wheels is with the open end of the chevron tread coming in contact with the ground first; however, the opposite mounting is correct for rear wheels. Actual service has indicated that better steering and increased traction are obtained when the tires

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AMMUNITION
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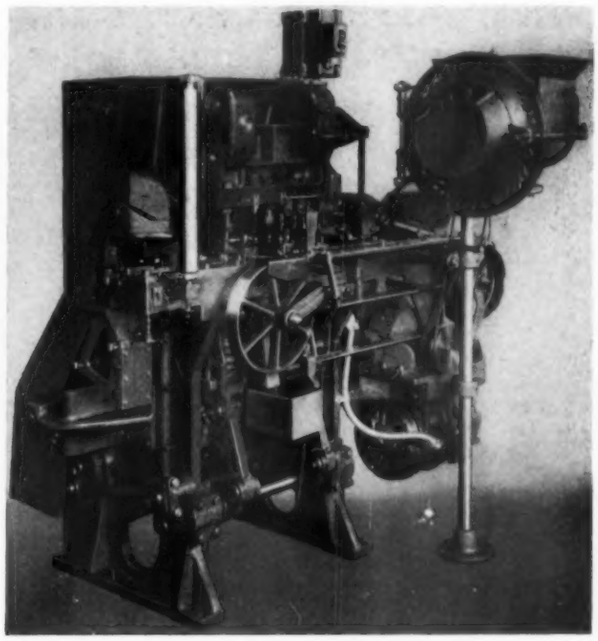

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are so mounted. Neither directional nor nondirectional tires should be permitted to run too long in one direction. Reversing direction may be required at as low as 3,000 miles in order to prevent uneven wear. It should be remembered that a tire which wears unevenly also wears at a faster rate than that with smooth wear.

A SYSTEMATIC plan of rotating tires increases mileage materially. Records of a number of tractor and trailer operations indicate that the rate of wear is definitely slower on front wheels than on rear wheels. A typical example indicated that, in this particular service, tires applied on rear wheels were worn smooth in 15,500 miles; whereas, if originally applied to the front wheels, they gave 20,000 miles before being removed to the rear wheels. After being removed to the rear, an additional 16,500 miles were obtained. This is a very sizable increase due merely to rotating tires at the proper time.

Not too great a differential should exist between the diameters of two tires mounted in dual assembly. A new tire should not be mounted with one considerably worn. Under such conditions, the larger of the two tires will carry an undue proportion of the load, and premature failure will probably follow. Except in cases of emergency, tires of different manufacture should not be mated on the same dual wheel as there are apt to be some differences in over-all diameters.

In commercial operations, brakes play a very important part in the service tires will give. Eccentric brake drums will tend to wear two flat spots (diametrically opposite) on tires. When a brake drum becomes eccentric, it should either be replaced or made concentric. Such machining should be done while the drum is attached to the wheel and hub with which it will be used; otherwise, eccentricity may still exist after mounting. One extremely severe application of brakes may start a flat spot on a tire; once it starts, it probably will continue to wear in that one spot, due to the wheel usually stopping on that spot of the tread. Unequalized brakes not only have an effect on tires but also on the operation of the vehicle. Cases have been reported where the mileage was practically doubled by properly equalizing brakes front and rear.

There is no question but that the efficiency of vehicles as well as conservation of rubber can be increased by proper maintenance and servicing of tires while on the vehicles. After being removed, they should be carefully inspected by properly trained men before being scrapped.

An Exhibition of Colt Percussion Revolvers

THE Metropolitan Museum of Art announced the opening, on February 4th, of a timely loan exhibition of Colt percussion revolvers which will remain on view through May 3rd. The 130 pistols in the collection—ancestors of the present-day military weapons—date from 1836, the year Samuel Colt patented the first multifiring arm, to 1872. There are included some twenty different examples of the earliest Colt model, known to collectors as the "Paterson," for they were made at Paterson, N. J., from 1836 to 1842; the "Whitneyville Walker," the rarest and most valued type of Colt; the "Wells Fargo"; and a sequence of military revolvers including replicas made in the Confederacy during the Civil War. The various ways in which percussion-cap Colts were converted to load metallic cartridges is illustrated in specimens from the period immediately preceding the introduction of the famous "Frontier Six-Shooter," issued in 1873, and still made today.

A painting by William M. Harnett, entitled "The Faithful Colt," has been loaned to the exhibition by the Wadsworth Atheneum. This presents the Colt saga in another medium. Early Colt revolvers are vital souvenirs of stormy periods of this country's development, such as conflicts with the Seminole Indians and border trouble involving the Texas Rangers.

Aside from examples of purely mechanical perfection, there is a group of enriched presentation revolvers. The burled walnut grip of one navy model is carved to represent the Charter Oak and is inlaid with mother-of-pearl; others are engraved with scenes of Indian wars, naval engagements, and stagecoach hold-ups. There is shown a pistol once owned by Gen. Andrew Porter of the Union Army; a dragoon given to Gen. José Rufino Echenique, the President of Peru; and a pocket pistol presented to Col. Thomas H. Seymour, Governor of Connecticut and Ambassador to Russia. Three pistols, beautifully inlaid in gold, of the type presented by Col. Samuel Colt to the Czar of Russia, have been loaned by the Colt's Patent Fire Arms Manufacturing Company. The other lenders are Albert Foster, Jr., John E. Parsons, Philip R. Phillips, Edwin Pugsley, Richard D. Steuart, and the Wadsworth Atheneum.

New Type of Helmet Liner

A NEW type of helmet liner which will be issued "in lieu of other headgear" for soldier wear, has been designed and service tested by the Army. Made of a new type of laminated plastic which has been under development in the standardization branch of the Quartermaster Corps for several months, this new item of equipment will be worn not only in camp and field, but also off duty. Distinctive insignia may be worn on the front of the liner when desired. It weighs about seven ounces and looks almost exactly like the recently designed steel helmet under which the liner is to be worn in actual combat conditions.

The plastic material used in the manufacture of the liner is the result of coördinated work by the best technical experts in the plastic industry, including representatives of the inland division of General Motors, the Westinghouse Electric & Manufacturing Company, and the Mine Safety Appliances Company.

The plastic is made by impregnating a strong section of cotton cloth with a synthetic resin. This combines the strength of the cloth with the durability of the resin. The material is "thermo-set," which means that the plastic is formed and heated under pressure so that it maintains its size and shape indefinitely. Tests conducted by Quartermaster technicians indicate that the liner can be worn to equal advantage in the heat of the tropics or the extreme cold of the Arctic Circle without apparent effect on the shape or utility.

Despite its light weight when worn without the steel helmet, the liner offers considerable protection against stones or small missiles. It was designed to give approximately the same kind of protection for everyday wear as the safety helmets worn by miners and those who work along roads. Recent tests show that a one-pound ball, dropped from a height of fifteen feet, will do no damage.

The inside of the liner looks something like the interior of the modern football helmet for it contains a network of webbing material that keeps the head from contact with the helmet and therefore serves as a cushion against a direct blow. This webbing is so constructed that any size headband can be inserted. The liner also contains a neckband and an adjustable chin strap. Also developed for wear with the liner is a knitted cap that is used to protect the wearer against cold weather. This is provided with ear flaps that can be worn up or down.

Abbreviated Special Orders

THREE letters do the work of a sentence, and other economies of time and materials are effected by a new form of the special orders issued daily by the War Department.

For example, the letters "TDN" replace the phrase, "Travel directed is necessary in military service"; "DP" replaces "By direction of the President"; "WP" indicates "Will proceed to," and "TPA" means "If travel is performed by privately owned automobile for permanent change of station."

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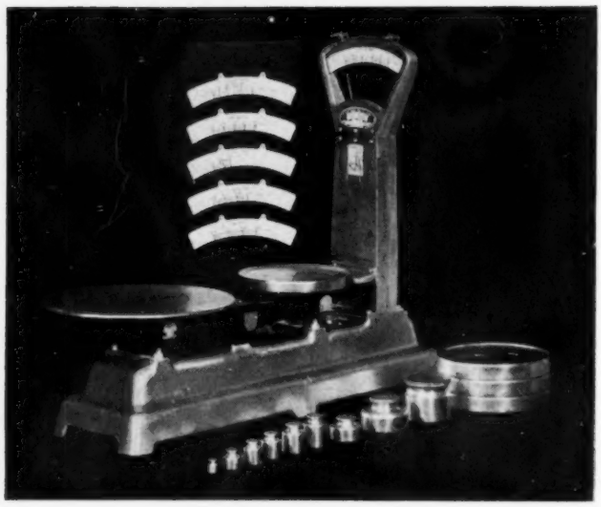

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A "block" system of paragraphing is also authorized for use wherever practicable. This system provides for the inclusion of a maximum number of names under one paragraph heading, thus eliminating repetition of identical headings. For example, a recent issue of special orders listed the names of six officers under the head: "DP following Reserve officers ordered to AD WP fr home to sta on date indicated TDN." Written out this reads:

"By direction of the President, the following Reserve officers are ordered to active duty. They will proceed from homes to stations on dates indicated. The travel directed is necessary in military service."

Armored Divisions Reorganized

REORGANIZATION of the Army's five armored divisions to provide more medium tanks than light tanks, self-propelled assault artillery, substitution of armored cars for scout cars, and changes in basic units composing the divisions has been authorized by the War Department. New tables of organizations are now being issued to the various armored divisions.

The new organization provides for increased effectiveness in combat by easy separation into two combatant groups, each of which will be able to carry out independent action. The strength of the divisions will remain unchanged; however, the armament will be augmented by the addition of more heavy weapons. Under the new organization, the division will have approximately the following number of guns and vehicles: 158 light tanks, 232 medium tanks, no scout cars, 79 armored cars, 54 self-propelled 105-mm. howitzers, 39 self-propelled 75-mm. howitzers (in addition to 75-mm. guns in tanks), no 75-mm. guns, 27 self-propelled 37-mm. guns (in addition to 37-mm. guns in tanks), 24 mortars (81-mm.), and 38 mortars (60-mm.).

Rubber Conservation

APPROXIMATELY 43,000 long tons of rubber will be saved during the next two years as the result of an agreement by the Army, Navy, and Marine Corps to accept for noncombat uses automotive tires manufactured from a modified compound containing a percentage of reclaimed rubber considerably higher than is at present being used.

In an effort to meet the shortage of crude rubber, the Under Secretary of War, Robert P. Patterson, in coöperation with the rubber and rubber products branch of the War Production Board, has formulated a program based on the three following essential steps: (1) To reduce the amount of rubber wherever possible by the substitution of less critical materials in items required by the War Department; (2) To eliminate all nonessential items entirely; (3) To standardize and simplify products requiring rubber, thereby reducing the number of items that would otherwise have to be carried in stock.

Since approximately sixty per cent of the Army's rubber requirements go into automotive tires, the largest single savings will be made in this item. However, specifications for other essential Army materials have been altered further to conserve crude rubber. The rubber content, for example, of rubber boots is being reduced from 62 to 47 per cent, and the rubber in face blanks for gas masks will be cut 20 per cent without in any way impairing their effectiveness. Combs for enlisted men are already being made of plastics rather than rubber. Steel wheels will be substituted for rubber on such portable engineering equipment for the Army as concrete mixers and portable air compressors.

"The reduction of the quantity of rubber used in all Army items and equipment to a minimum, as well as the complete substitution of other materials, is being vigorously prosecuted by the Supply Arms and Services," Mr. Patterson said. "We are going ahead on rubber conservation, and we're going ahead on it right now. This new program is already in effect."

From the Record

THE FUNCTIONS OF MODERN AIR POWER WHICH have been developed and demonstrated during this war have vitally affected previously approved methods of warfare. They have been carefully studied by our own Army and have powerfully affected our plans and organizations. Fortunately, our own Air Corps has kept itself in the forefront of this development even before the recent startling disclosures of the conflict itself. American construction has been in the van of the progress which is now making possible a striking arm of extreme mobility and phenomenal range. The development of our flying fortresses, which have just demonstrated their supreme characteristics over Germany, was begun by the American Air Corps in 1934.

The recently demonstrated effectiveness of air power as against sea power in the confined limits of the Mediterranean has suggested revolutionary possibilities for the defense of American interests in the similar seas of the southwestern Pacific. It has also suggested the enormous powers of a hemispheric defense which, radiating out from the manufacturers and training grounds of the United States and taking advantage of our now existing ocean and continental bases, may strike at and ward off aggressive hostile sea power long before it is able to come near to our shores. . . . Naturally such a revolutionary growth of air power could not take place without differences of opinion as to its proper organization and control. These differences of opinion have been world-wide and the air power of different nations has been developed on patterns and under methods which have differed from each other. In America, we have had the advantage of studying the effect of the test of war upon these differing theories and methods.

We are trying to give the organization of our own air force the full benefit of the lessons which have been thus learned. From them there seem to stand out certain clearly demonstrated principles. An air force should have the freedom through independent experimentation and research to develop new forms of aircraft which will embody the latest improvements in the manufacturing art as well as the power to procure for its own force such new types of planes. It should also have the freedom to plan for their effective use and to select and train the special personnel—pilots, bombardiers, navigators, observers, and mechanics, necessary to operate the planes. It should have the power to create an air staff to plan air strategy and effective coöperation with ground and naval forces, and it should have the power to insure the permanence of the technique which it thus creates by the training and creation of an adequate permanent force of Regular officers.

On the other hand, when it performs its final and most critical function, namely, that of fighting in coöperation with armies on the surface of the land or navies on the surface of the sea, it must submit itself to the conditions which make that coöperation as perfect as possible. And the experience of this war has fully demonstrated that such coöperation cannot be perfected without a unity of command and that this unity of command cannot be successful unless it extends to combined training taken in preparation for coöperation as well as to the acts of coöperation themselves. The principle of unity of command, however, applies not only to specific theaters of operations. For the Army as a whole, air and ground, there must be a single head for the final determination of broad policies and especially for the allocation of forces to various purposes or theaters, within the discretion of the constitutional commander in chief.

In our recent revision of the organization of the Air Corps, we have endeavored to carry out these guiding principles. The rival views formerly held in the air and ground forces have, I

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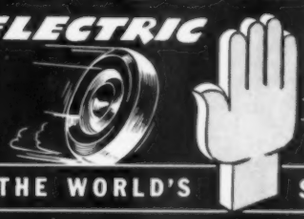

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From the Record

believe, been thoroughly reconciled and the soundness of the new organization is now cordially acquiesced in by both sides. At the recent maneuvers in Louisiana there were employed at least four types of combat planes which were concededly superior to any yet produced by the warring nations of Europe. In their work of coöperation with the ground forces at those maneuvers, our airmen displayed a spirit and a technique of coöperation which, in the light of their comparatively brief training, was astonishing. An organization which can produce such results in so brief a time should not be subjected to the destructive efforts of hasty legislation. We have been progressing by an orderly and good-tempered evolution. It is no time for the intervention of arbitrary or ill-advised experiments.—*Henry L. Stimson, Secretary of War, in his annual report for 1941.*

MENTION IS MADE BY THE COMMITTEE OF THE partial nonconversion of the automobile industry and of the continuance of manufacture of unnecessary civilian supply. The War Department has always put the defense effort first, and will continue to do so. No one has protested more strongly than the armed services the use of materials and labor in making unnecessary consumers' goods. You can depend upon the armed services more than any one else to carry out your views that war production is the first thing and that everything must be subordinated thereto. In fact, it has been only our constant vigilance which has prevented a larger continued use, or a larger diversion of materials, machines, and labor for nonmilitary goods. No civilian board could possibly feel more strongly than the War Department on this subject. If the War Department is given the appropriations and the support of the Congress and of the nation, then no usable existing facility, large or small, will be left out of our program.

The armed services are the only agencies competent to determine what we need, how much we need, and when we need it, as well as the relative urgency or priority of the needs, as these factors apply to plans for strategic operations. I do not understand that there is disagreement on these points. Likewise the War and Navy Departments are the only agencies that have technical military experts informed, as a result of many years of training and experience, as to the country's industrial facilities which can be used by conversion or otherwise in the production of munitions. This I have referred to previously in connection with our plans for industrial mobilization.

Many, perhaps most, of our items must meet difficult specifications required in modern mechanized warfare. We must be certain that we supply to our soldiers products meeting the requirements. Otherwise their lives and the whole future of the country are imperiled. The placing of orders or subcontracts by civilian authority would not only disrupt the system of procurement now in effect, which is the result of plans and experience developed over many years, but might lead to the production of articles which would have to be rejected, although the need was great. We cannot effectively change our system in the middle of the stream. Those responsible for delivering what we need, namely, the armed forces, must also have the duty of seeing that we get it and that it works. There should be no divided responsibility here.

The idea of a civilian board of Ministry of Supply is not new. It was considered during the last war and discarded after careful consideration in favor of the method of strengthening a going and successful organization of men who knew their job. I do not believe you will find those civilians who are most familiar with the problems favoring the taking of procurement of munitions away from the armed services and placing it in inexperienced hands.—*Robert P. Patterson, Under Secretary of War, before the Select Committee of the U. S. House of Representatives Investigating National Defense Migration.*

Ordnance Field Service

The following articles are republished by permission of the editor of the New York Times.

ARMY ORDNANCE TANKS IN THE DESERT CAMPAIGN

Cairo, Egypt.—Brigadier A. H. Gatehouse, commander of the British 4th Armored Brigade, which so ably used United States light tanks during the British offensive in Libya, has long been a strong supporter of American tanks, but now, with the first phase of the campaign completed, he cannot say enough in praise of them. He has cited instance after instance in which the United States-built machines proved their superiority in speed, endurance, maneuverability, and ease of handling.

It was the 4th Armored Brigade that during the entire drive, until Gen. Erwin Rommel's retreat, constantly circled the German forces, finally forced them to charge westward into the setting sun, and then shot the vehicles of the half-blinded tank crews to pieces. When General Rommel finally made a run to Agedabia, it was fast American tanks that first reached the Gulf of Sidra area and began to harry the retreating Nazi columns.

Statistics of the performance of these tanks and the men who drove them are amazing. Previously no British tank crew ever operated more than five days in succession, and the Russians were supposed to hold the record of ten days, but men of the 4th Armored Brigade drove the American tanks through thirty-two days of continuous service.

The men were so tired that at night they simply crawled out of the tanks and fell exhausted on the cold sand, sleeping without even bothering to cover themselves with blankets. In the mornings they had to be kicked to be awakened. They often were unable to eat naturally and hot liquids practically had to be forced upon them. If tanks were halted when moving by night, and even sometimes by day, officers had to go back along the line to awaken the drivers to get under way again.

Working under these conditions, the men naturally had no time for tank maintenance. They simply put gas, oil, and water into the machines and drove them. Yet during the entire thirty-two days there were only twelve minor mechanical failures among ninety tanks. One squadron of the tanks received an average of five direct hits each, but only two were disabled sufficiently to be stopped. The Second Command of the 3rd Royal Tank Regiment drove his American tank 900 miles under battle conditions without one mechanical failure.

Proof of the effectiveness of the American tanks included the citation that Brigadier Gatehouse received in the Distinguished Service Order for his "marked success and determination."

Once Brigadier Gatehouse moved an entire unit through the rough desert at an average speed of twenty-eight miles an hour, which meant thirty-five miles an hour most of the time, though the going was so bad that third gear often was necessary. (*The New York Times, January 3, 1942.*)

MAINTAINING AMERICAN TANKS IN LIBYA

Cairo, Egypt.—Somewhere in Egypt, where the green valley of the Nile fades into the deep brown hues of the desert, stands a tank-maintenance plant which, although still far from perfect, illustrates what Anglo-American coöperation may achieve in doing an actual war-time job.

Staffed and directed at present by British personnel, the plant was built under American supervision along lines worked out by the United States Army. Its job is to equip new United States-built tanks for desert warfare in Africa and Asia and to overhaul and repair those machines that mechanical wear and enemy

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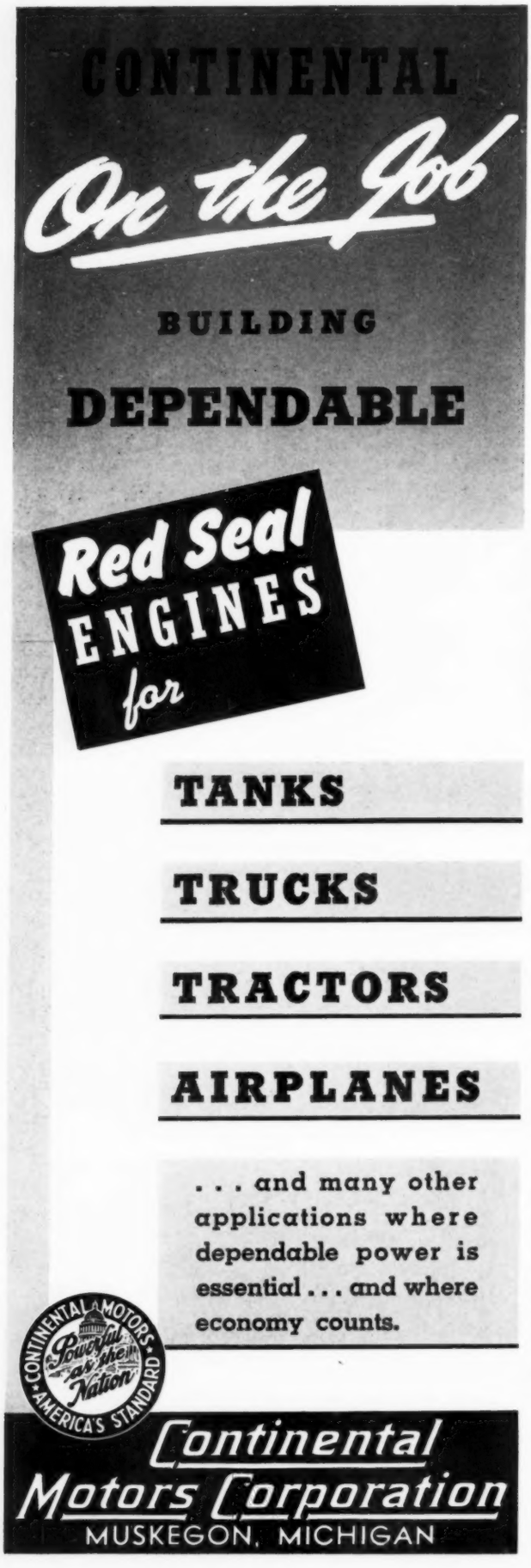

Ordnance Field Service

shells have put out of action. There are other plants that do a similar job for British-built tanks.

According to Maj. Henry Herbert, a British engineer who now directs the plant, credit for organization of this effective maintenance system is to be accorded chiefly to Maj. Joseph M. Colby of the United States military mission, and to Col. Charles Sellers of Britain, who now directs not only the American section but British tank maintenance as well. Several experienced American tank corps officers and noncommissioned officers have assisted in training the British staff that now operates the plant. Both Colonel Sellers and Major Colby often have been called to various points to solve tank-maintenance problems that have cropped up during the British offensive in Cyrenaica.

The United States was not in the war when this tank project was begun, but through this assistance "short of war" the United States Army helped along Britain's Libyan offensive. Major Herbert speaks often of the part that Major Colby and other Americans played in sending United States-built tanks into action and keeping them there. Major Colby, in turn, says that nothing could have been accomplished without the aid, first of Colonel Sellers and then of Major Herbert.

Tanks do not run like automobiles and, although the United States-built tanks require only about a tenth the attention demanded by the best German models, they would worry an ordinary garage mechanic into an early grave. Without the tools, equipment, and plant organization especially designed for them, tanks become all too soon useless derelicts. The life cycle of United States-built tanks in Africa begins and ends in this maintenance plant. The moment a machine or a consignment of parts reaches a Middle Eastern port it is put under the care of Colonel Sellers' representative, who sees that it gets off the docks on its way to the shop. Whether a tank is consigned to the Sudan or to Libya or to Iraq, it is likely to start out this way.

When a new tank arrives it is still covered with protective grease and waterproof paper. It is run into a shed, and boxed accessories inside it are removed and carefully stored. This also gives mechanics a chance to work inside the cramped interior of the machine. The new tank is checked to see that all parts are complete and in working order, and minor alterations are made to fit it for desert warfare. One alteration is the addition of sand guards over the tracks.

As soon as the tank is in working order it is equipped. It takes many accessories to insure readiness for any emergency. Into the tank go cushions, flashlights, helmets, a fire extinguisher, a sledge hammer, a pick, a shovel, a tarpaulin, signaling equipment, a machine gun, ammunition belts, a tommy gun and clips, first-aid equipment, a gas cooker, a 2-way radio, and an oil can like that used for locomotives.

When a United States-built tank is too badly damaged for repair in the field, it is sent back to the base maintenance plant. There it is towed into a shop by an American tractor and is checked over by expert mechanics. The unit is partially dismantled and various elements are sent to a parts shop that is equipped to deal with them. If necessary, two or three tanks are torn down and one good tank built from their parts. New spare parts are on hand when they are needed, however. These are kept in bins and are as carefully catalogued as books in a library. But only a third of them are in the bins at any given time; the remainder are dispersed in bulk storage, so that no well-placed bomb can destroy all of some vital part. No spares are ever allowed to remain packed even a short time after arrival; otherwise it might be hard to get at something urgently needed.

When a tank is repaired, it is sent back to that part of the front where it is most needed, and there it begins a new life cycle. When a British commander of a unit received a number of United States-built tanks during the first week of the Cyrenaican offensive he could not say enough in praise of the maintenance unit and the American officers who had helped so much in creating it. (*The New York Times, January 4, 1942.*)

Ordnance Districts

This is the first of a series of articles about the organization and accomplishments of the various Ordnance Procurement Districts to be presented from time to time in the pages of ARMY ORDNANCE. *The following items about the Rochester Ordnance District are written by Lieut. Col. Roy L. Bowlin, Ord. Dept., Executive Officer of the district, Rochester, N. Y.*

ROCHESTER ORDNANCE DISTRICT GAGE LABORATORY

WITHOUT interchangeability of parts in the assembly of ordnance matériel, the *"Blitz"* would be taken out of *"Blitzkrieg."* Since this type of warfare is the style today, interchangeability must be the keynote of the greatest mass-production effort history has ever known. When we speak of interchangeable mass production, we come face to face with the problem of gages, gage design, and gage checking.

Foresight of the Ordnance Department was responsible for the establishment of gage laboratories in nine out of the fourteen Ordnance districts. These laboratories served as training centers for personnel from the time they were started until the present emergency when they have been placed on an active working basis. The Rochester Ordnance District was one of those districts not favored with a gage laboratory, except the one located at Watervliet Arsenal, 250 miles from the district headquarters. Therefore, when the full impact of the national-defense effort finally descended on the district, a real need was felt for the immediate establishment of a gage laboratory to care for the demands of one of the most highly concentrated industrial sections of the country.

The Rochester Ordnance District gage laboratory officially originated October 8, 1940, with a letter from the Office of the Chief of Ordnance granting authority to set up a laboratory similar to those in other districts. Real progress can be dated from the time that Maj. William J. Darmody was ordered to temporary duty in the district. He was able to give the first concrete ideas of just what was needed in the way of equipment, space, constant-temperature equipment, and, borrowing from his extensive experience, what substitutions of equipment would be to advantage—such as the use of the contour projector in place of the toolmaker's microscope and the substitution of internal micrometer plugs by internal indicators covering a wider range of sizes with greater accuracy of measurement.

Foundations having been laid, work was started in each of many channels, such as ordering equipment, obtaining personnel, setting up records, etc. It was found necessary to make use of an A-1-a preference rating in the ordering of equipment. A constant surveillance of applicants was maintained in order to find men with the exacting experience and the training necessary for gage checking, for there was a real necessity to get the best job done in the shortest time.

A constant-temperature room was necessary for the performance of extremely accurate work. The most desirable type of air-conditioning equipment was not available when needed, so an air-cooled unit was installed until such time as the water-cooled unit, now installed, could be obtained. Metal shelving cabinets, work benches, and stools were purchased to fill the needs of the gage checkers. As gage blocks, measuring wires, and optical flats were received by the district office, they were immediately dispatched to the National Bureau of Standards for checking, enabling the district office to set up accurate reference measuring equipment.

Standard shielded incandescent lighting was not found satisfactory in the gage laboratory, so a change was made to fluore-

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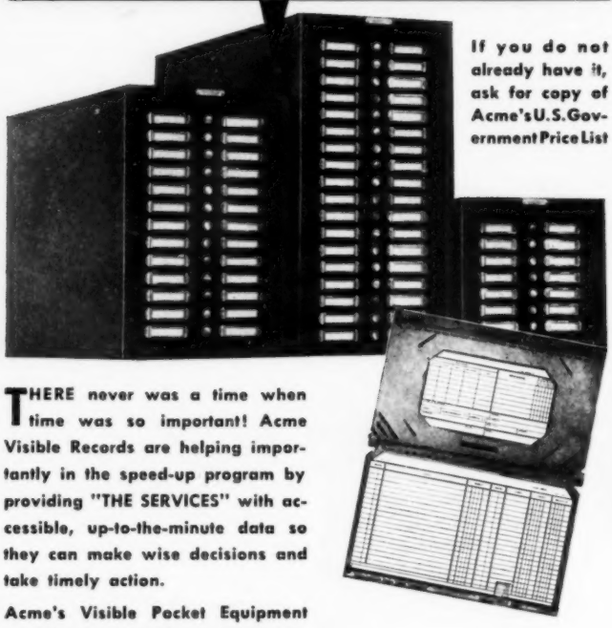

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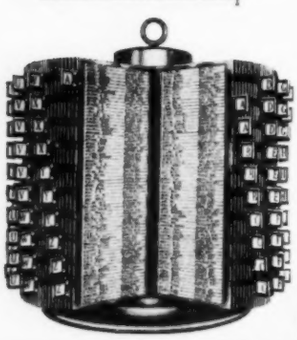

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Ordnance Districts

scent lighting which gave a much higher level of intensity as well as a higher quality of glareless, shadowless lighting. The new lighting reduced the eye fatigue encountered in long periods of fine work with a resulting increase in efficiency of personnel.

All personnel in the gage laboratory are given the same training after their employment by the district. A short period is spent in the district laboratory becoming acquainted with the problems encountered there, after which they are sent to Watervliet

SUPERMICROMETER IN THE GAGE LABORATORY

Arsenal where they are given an intensive 10-week gage-checking course under the capable direction of L. W. Dwyer, gage engineer at the arsenal. This course covers all the fundamental principles of precision measurements, as well as those problems peculiar to Ordnance Department gages. A great deal of time is devoted to actual gage checking involving the use of all types of measuring equipment. This method of training has proved outstandingly successful.

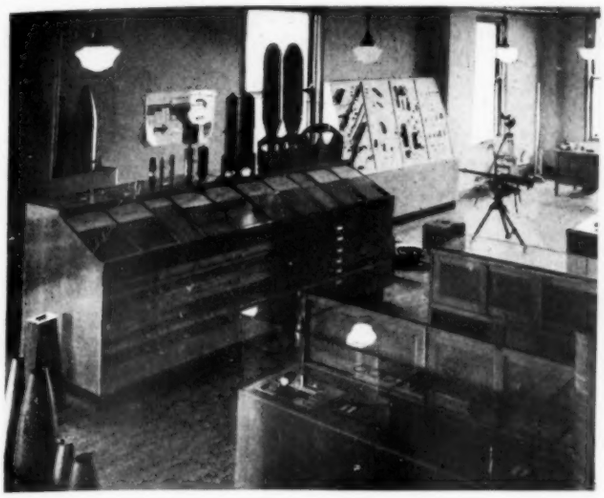
When gages are received broken, worn, or rendered obsolete by component changes, a man is detailed to take the gage or gages in questions to various shops in the city to obtain three bids on the repair work. This procedure has worked out satisfactorily in general, but it has been found more economical to install small toolroom machines to work in conjunction with the gage laboratory. These tools include a 9-inch back-geared bench lathe with a complete set of attachments, drill press, bench grinder, bench milling machine, and small surface grinder. The bench grinder more than paid for itself on one job.

As circumstances are encountered in the field which call for supervisory measures by the district office, directives are sent out dealing with the particular problem at hand. Subjects covered by some of the recent directives are "Requests for Additional Inspection Gages," "Coördinating Inspection and Work Gages as Designed by the Rochester Ordnance District" (dealing with dimensions and tolerances on inspection and work gages so that parts passing the work gages will readily pass inspection gages), "Worn or Broken Inspection Gages" (dealing with data to be turned in on forms showing the actual life of gages as compared with estimated life of gages).

A reconnaissance car has been obtained and set aside for the exclusive use of gage laboratory personnel. This car has been fitted with cases and shelving as well as a heater to minimize temperature effects during the winter. Complete gage-checking equipment is carried, enabling the traveling gage checker to go to a manufacturing plant where there is gage trouble and check or trace the trouble without having to resort to a great deal of correspondence as well as shipping and reshipping of gages with

consequent loss of time. The traveling gage checker has been in operation but a short time so that evaluation of savings of time and money is difficult at present.

Quite extensive gage design has been carried on by the laboratory personnel. A good illustration is the situation encountered on a contract for 40-mm. shell produced in the district. The company had been authorized by the Government to manufacture two complete sets of gages as there were no gages available when the contract was signed. The company designed what they thought were satisfactory gages, and while the designs were acceptable



THE DISPLAY ROOM AT ROCHESTER

from a commercial standpoint in so far as checking dimensions at various points on the shell was concerned, changes in design were deemed necessary. Both sets of gages were redesigned and redimensioned to conform with arsenal practice; that is, one set was dimensioned to the twenty per cent rule for work gages, the other being dimensioned to the ten per cent rule for inspection gages. Thus, parts passing the work gages would be sure to pass the inspection gages. When the gages were finally delivered, they were checked in the district laboratory and found acceptable with one exception, this being corrected by the gage manufacturer. This is but one of many instances where the gage laboratory has assisted a manufacturer to get into production in a shorter time and with the assurance that his product will be acceptable.

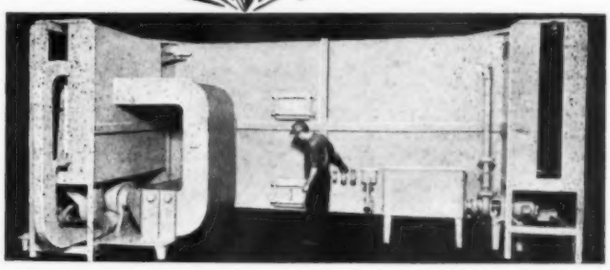
There is little doubt but that the increased production planned for 1942 coupled with the fact that many existing contracts have not progressed to such a point as to cause any wear of gages, will throw a still heavier load on the facilities of the laboratory. Personnel is being increased and all preparations made to meet the increased load when it comes.

ROCHESTER DISTRICT DISPLAY ROOM

JUST as a picture is worth a thousand words, so the actual subject of the picture itself is worth a thousand pictures. With this thought in mind, Maj. Gen. C. M. Wesson, Chief of Ordnance, in January 1941, directed all Ordnance district executive officers to install display rooms as part of their respective district headquarters. These rooms for the display of ordnance matériel, showing the manufacturing processes necessary, afford manufacturers an opportunity to examine in detail such items as they might be equipped to produce, and furnish essential manufacturing information on these items.

The Rochester Ordnance District is using a large room available at the district headquarters for its new display room. The new floor covering was hardly laid before the display fixtures were being installed. These fixtures, designed by district per-

2 NEW WEAPONS FOR WAR !



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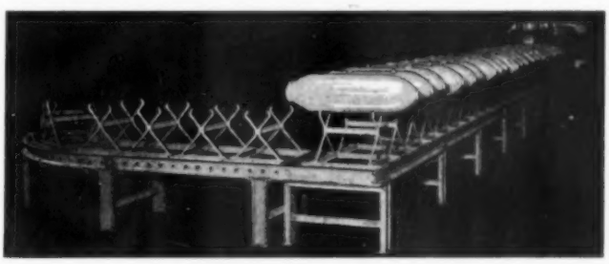

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Ordnance Districts

sonnel, are finished in light oak to correspond with the trim of the room. A large glass showcase placed approximately in the center of the room displays optical and fire-control instruments. Three large square display stands are used for finished items, such as machine guns, fuzes, forgings, carrying cases, etc. Eight racks line the walls for the display of optical elements, fuzes, small arms, shell cases, and projectiles. These displays consist of disassembled matériel mounted on masonite sheets finished in flat ivory. Red, blue, and green strings show the relationship of the various parts—green showing parts which form a subassembly, blue indicating single parts going into assembly groups, while a red cord connects these assemblies to the main part or parts. Each separate part shown is labeled with its proper name and drawing number, giving a comprehensive picture of the steps necessary to completely assemble each item. There is also a large display cabinet designed to accommodate drawings, photographs, descriptions of manufacture, and various Ordnance publications.

The bulk of the matériel on display has been obtained within the boundaries of the Rochester Ordnance District. Inspectors of ordnance matériel and Army inspectors of ordnance at the various manufacturing plants were contacted and instructed to obtain complete sets of parts which, while rejected for dimensional failings, were acceptable for display, inasmuch as they showed the manufacturing processes necessary. Many items have been sectionalized, increasing their value for the type of display intended. Only the following items were chosen for display: (1) Those which were easily adaptable to commercial manufacture; (2) Those which could be taken for display without depleting equipment needed by combat forces; (3) Those which would not be manufactured as completed matériel in single-purpose plants; (4) Those which would be required in quantity.

A complete technical library is the goal of the district display room. The large cabinet previously referred to, provides space for the storage of many drawings and descriptions of manufacture, technical manuals, field manuals, and charts, as well as visible-type folders for the convenient display of photographs.

The display room has served many uses other than that of assisting potential contractors. It has been used extensively to train and acquaint district personnel, including clerical and stenographic as well as technical employees, with ordnance equipment and manufacturing procedures. In addition, it serves the procurement-planning section as an aid in obtaining preliminary capacity estimates by allowing manufacturers to inspect the display items and, in some cases, to obtain samples for more detailed study. In some instances, prime contractors in other districts have requested facilities located in the Rochester Ordnance District to subcontract various items. These potential subcontractors, by visiting the display room and examining the subassemblies in which they are interested, have been able to enter tighter and more accurate bids.

Training courses for inspectors of ordnance matériel at present are being planned at district headquarters to replace or augment the arsenal training schools. A training course for inspectors of optical items is in operation. The display room and gage laboratory both fit into the training picture as very definite supplements to these courses.

Since classified items are on display, the room cannot be opened to the general public. Paragraph 5a of the Restricted Appendix, Ordnance Department Order No. 128, clearly states the reason for this restriction as follows: "Whenever documents or other items disclose information regarding engineering principles and designed details, composition, method of processing or of assembly which are vital to the function or the use of the article, they will be marked 'Restricted.'" So, whenever a visitor wishes to inspect the display room, he must register with the district receptionist, sign his name, give the company he represents, the purpose of his visit, and other pertinent information.

Book Reviews

AUTOMATIC ARMS. By Melvin M. Johnson, Jr., and Charles T. Haven. New York: William Morrow & Co. 344 pp. $4.50.

FOR the first time since 1917, the American student of small arms not conversant with foreign languages can regale himself with a volume devoted solely to machine guns, automatic and semiautomatic weapons—one so carefully prepared, pleasingly written, and comprehensive in its coverage that it will long remain a landmark in the literature. For Messrs. Johnson and Haven appear to have conducted as complete a study of the whys and wherefores of machine-gun operation and application as has ever been made in the history of that device. Their exposition of the various systems under which self-actuated firearms operate is so lucid and logical that even the most unmechanical should be able to derive from it a fair working knowledge of "what makes the wheels go 'round."

Strictly speaking, a machine gun is actuated by a force externally applied, as through the manual operation of a hand crank, in contrast with the "automatic" which derives, from the mechanical application of a portion of the power generated on the firing of its initial round, the energy required for loading and discharging another, the cycle then repeating until the ammunition supply is exhausted or pressure on the trigger released. But in practice, the two terms are used interchangeably.

Be it understood that the period between 1917 (when two excellent volumes on machine guns came forth—one in the U. S. A. by Hatcher, Wilhelm, and Maloney, and one in England by Longstaff and Atteridge) and the release of the present work was far from void of publications devoted to machine and automatic weapons. Nor did that year mark by any means the first recorded appearance of a volume devoted wholly to these subjects, for interest in quick-firing arms was already of long standing; as remotely as 1874 there had been printed in England a book by J. F. Owen on "Mitrailleurs, or Machine Guns." (The designation of "mitrailleur" later was supplanted by "mitrailleuse.") Between that date and 1900, however, little seems to have been written on the subject with the exception of two small books by John Henry Parker, based on his Spanish-American War experiences and devoted almost wholly to discussions of the tactical use of the machine weapon. In 1902, however, there came forth an interesting and useful German volume, "Die principiellen Eigenschaften der automatischen Feuerwaffen," by an anonymous author whose pen name was "Kaisertreu," followed in the year succeeding by a Spanish contribution, "Armas Automaticas," the work of D. J. Génova É y. Again a hiatus of considerable duration, broken finally by the publication in France of "L'Avenement des Armes Automatiques" (1925), by Marcel Devouges and more recently by a work of German origin, P. Curti's "Automatische Waffen" (1936). Practically all these works, save those by Parker, discuss in detail the various types of machine and self-actuating (automatic) mechanisms developed to their dates of publication and include chapters of varying length devoted to the history of multifiring weapons.

The book presently reviewed exhibits in a measure the combined characteristics of its predecessors in that it embodies a considerable historical section, goes carefully into the mechanics of different automatic and semiautomatic "systems" (the true "machine" weapon is now practically obsolete), and devotes some 110 pages to discussions of tactical considerations. Its authors have taken especial care to avoid the introduction of any material either tinged with self-exploitation, or controversial in tone, a wise provision in view of the bitter debates that long raged over the virtues of Captain Johnson's semiautomatic rifle.

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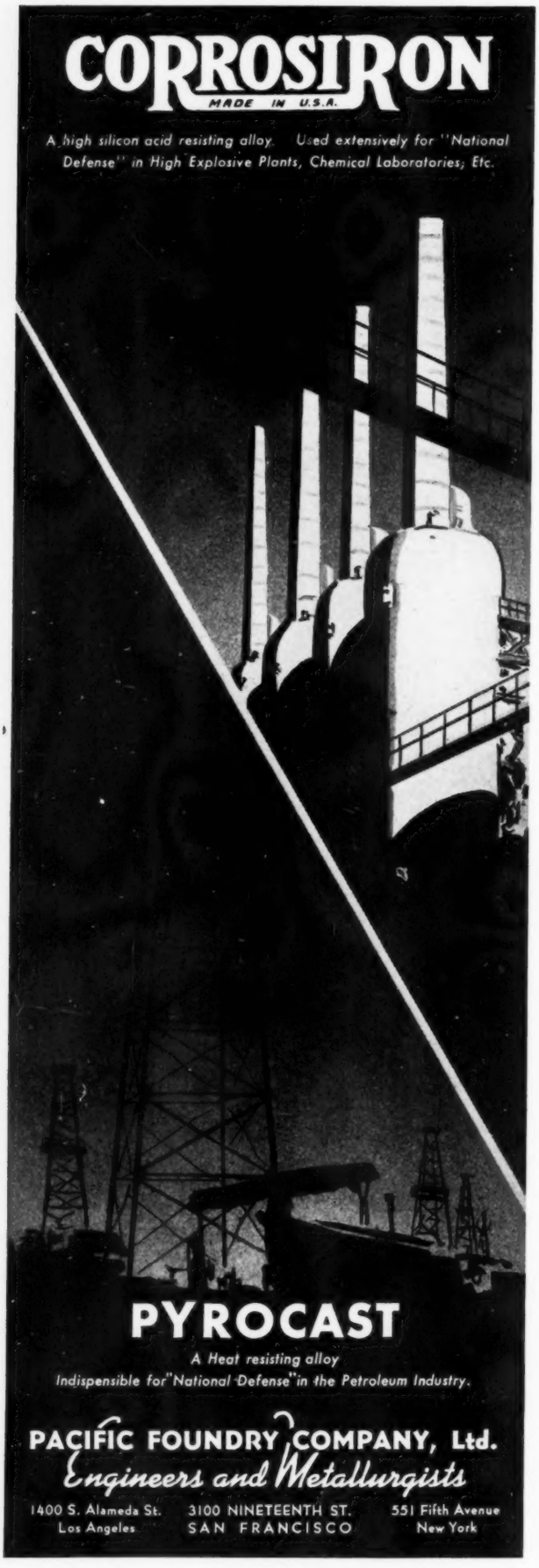
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Book Reviews

As a result they stand entirely clear of any accusation of special pleading and have produced a volume which appears to be beyond criticism in that respect.

One suggestion which occurs to the reviewer is that the historical matter on machine weapons might readily have been enlarged at the expense of some of that devoted to early repeating arms which, though of great interest, has scarcely a place in a work of this nature. There is a blank space in the literature which badly needs filling with many of the types developed concurrently with, and immediately after, the Gatling—an undertaking for which the authors of the present work are preëminently qualified. Thus, instead of descriptions of the first Colt revolver and the Henry and Spencer rifles of Civil War fame, it might have been more suitable to discuss the Ager, Claxton, and Vandenburgh guns which saw some service in that conflict along with the Gatling and Billinghurst-Requa, or to reveal the fact that the French employed the Gatling as well as the mitrailleuse in the affair of 1870-1871, and that the Germans, in the course of this "unpleasantness," used a machine gun of their own, the "Feld."

In like manner, one may question the wisdom of devoting practically one-third of the volume to long, and sometimes a bit tedious, discussions of tactical considerations indicating or contra-indicating the employment of this or that type of weapon in the infantry squad, its correct density of distribution if and when employed, its ammunition supply, accuracy, maneuverability, and general effectiveness. While these items are doubtless of great value to leaders of combat troops, they readily may prove unimpressive to the casual reader and would appear to belong more properly to the columns of journals devoted to the tactics and technique of the combat arms than in a volume such as is here presented.

But it is obviously impossible to please every one, and perhaps the authors have followed the wisest course in devoting considerable portions of their work to historical, technical, and tactical aspects of automatic arms, rather than to a lengthy exposition of some one of these at the expense of the rest. The result is a volume in which each element of the above-named trinity receives consideration sufficient to satisfy the reader who desires to be informed upon it alone to the exclusion of the two remaining. The historically minded will be pleased with the initial chapter on early multifiring weapons, followed by one on repeating and automatic pistols in which the evolution of these types is carefully traced and a goodly number of rare specimens illustrated. Chapter III discusses automatic rifles up to and including the World War, while the next covers postwar military developments in automatic and semiautomatic shoulder weapons, light machine guns, heavy machine guns, and automatic cannon.

Part 2 of the volume embodies chapters on "Classification of Automatic Weapons," "Factors Affecting Design," and "Methods and Systems of Feed," while part 3 treats of "Malfunctions and Stoppages," "Headspace," "Ammunition," and "Combat Notes." Part 4 is devoted to "Fire Effect," "Combat Efficiency of the Rifle," "Automatics in the Squad," "Considerations Affecting the Light Machine Gun," and "The Problem of Ammunition Supply." The fifth part comprises chapters on "Accuracy" and "Design and Critique of Automatic Mechanisms," followed by appendices in which are set forth in chart form the characteristics of the currently best-known automatic arms and infantry weapons, ammunition tables for these, etc. The book ends with section drawings of sixteen different machine-gun and automatic mechanisms, commencing with the French DeReffye mitrailleuse (here incorrectly labeled the Montigny, its Belgian precursor) and ending with the Thompson submachine gun.

On the whole, the work is reasonably free from errors or

omissions, though a number of these are evident upon careful scrutiny. The confusion of the DeReffye mitrailleuse (of twenty-five barrels) with the Montigny (of thirty-seven), the breech mechanisms of which were quite dissimilar in many details, has just been mentioned. LeFacheux is credited with the invention, in 1836, of the pin-fire paper shell, whereas the earliest cartridge invention ascribed to that gentleman is dated 1850, and most authorities assign to Houiller (1846) the development of that epoch-making mode of priming. The Bergmann muskete is described (p. 24) as fed from a 32-shot Luger drum magazine placed below the action, whereas all those with which the undersigned ever has come into contact carried this on the left side of the receiver.

The Chicago Arms Company "Protector" revolver firing caliber .32 extra-short rim-fire ammunition receives mention (p. 28), but its running mate, made in Minneapolis and handling an extra-short center-fire cartridge of the same caliber, is silently passed over. On the same page, the "Manufacture Française d'Armes et Cycles" becomes distorted into "Française Armes et Cajdes de St. Etienne," while on p. 32 the rare French gas-operated automatic pistol known as the "Clair" acquires an extra letter and becomes the "Claire." So also are misspelled the names of certain German and Spanish automatic pistols. No mention is made of the Smith & Wesson caliber .32, though the .35 is recorded. More serious is the insertion of a redundant "r" into the name of the British Colonel Fosbery whose semiautomatic revolver of .455 *and* .38 cal. (the authors mention the first only) becomes "Fosberry" on page 34. The Standard automatic rifle (pp. 56-57) is referred to as being chambered for cartridges of ".25-35, .30-30, and .35 calibers," whereas it is a matter of general knowledge that it took the entire line (calibers .25, .30, .32, and .35) of Remington *automatic-rifle* ammunition. In the same chapter, though most American .22 automatic rifles are mentioned, no reference is made to that offered to the public by the Batavia Arms Company in 1909—and sold by it in considerable numbers. On p. 148 the 7.65-mm. Luger cartridge is designated as of 7.62 mm., and on p. 216 the British musket of 1776 to which Greener, whose tables on such subjects appear quite dependable, ascribes a weight of 11 pounds, 4 ounces, is said to have "weighed 15 pounds."

On p. 298 we learn that "the Mauser-type bolt system has been used throughout the world for the past forty-odd years." This is approximately correct if the authors are referring to that system as embodied in *repeating* weapons, in which it first appeared in the Belgian Model 1889 (the German 8-mm. of 1888 is properly a Mannlicher, though often designated a Mauser). But the Mauser repeater evolved from its earlier single-shot (1869-1871) and that in turn from the Dreyse needle gun, also a bolt-action, the first military model of which was officially adopted as early as the 1840's. Perhaps least excusable of all sins of commission chargeable to these distinguished gentlemen, is the spelling of "deringer" (as derived from the name of Henry Deringer of Philadelphia, first to develop a weapon of that type), with an accessory "r" (*i.e.*, "derringer")—an error that does *not* appear in the "History of the Colt Revolver" of which Mr. Haven, one of the authors of the present work, was likewise coauthor.

TWO points strike the reviewer as he closes this fascinating volume. One is the extremely well-taken position of its authors to the effect that the problem of ammunition supply has existed ever since there were projectiles, and that the British longbowman could, by careless shooting, exhaust his stock of arrows just as readily as can, in like manner, the automatic rifleman of today exhaust his ammunition. Thus the solution of the ammunition bugbear becomes a function of the state of discipline and training within an organization rather than the ability of rear echelons to keep rushing additional rounds to front-line gunners. From which evolves the fact, so well demonstrated in this work, that the arm which achieves the most hits in the least time, other things being equal, is the arm of choice. On this basis, the semi-

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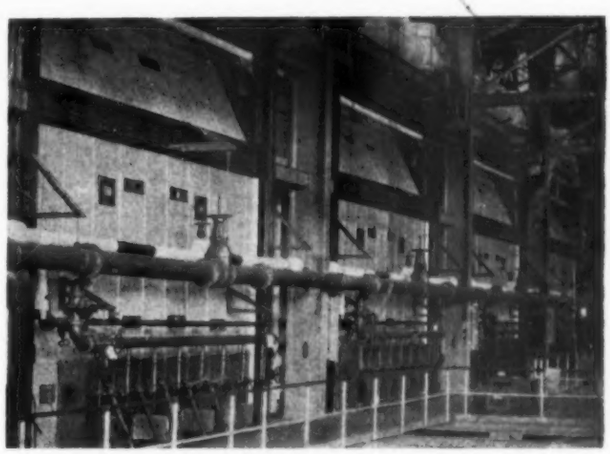

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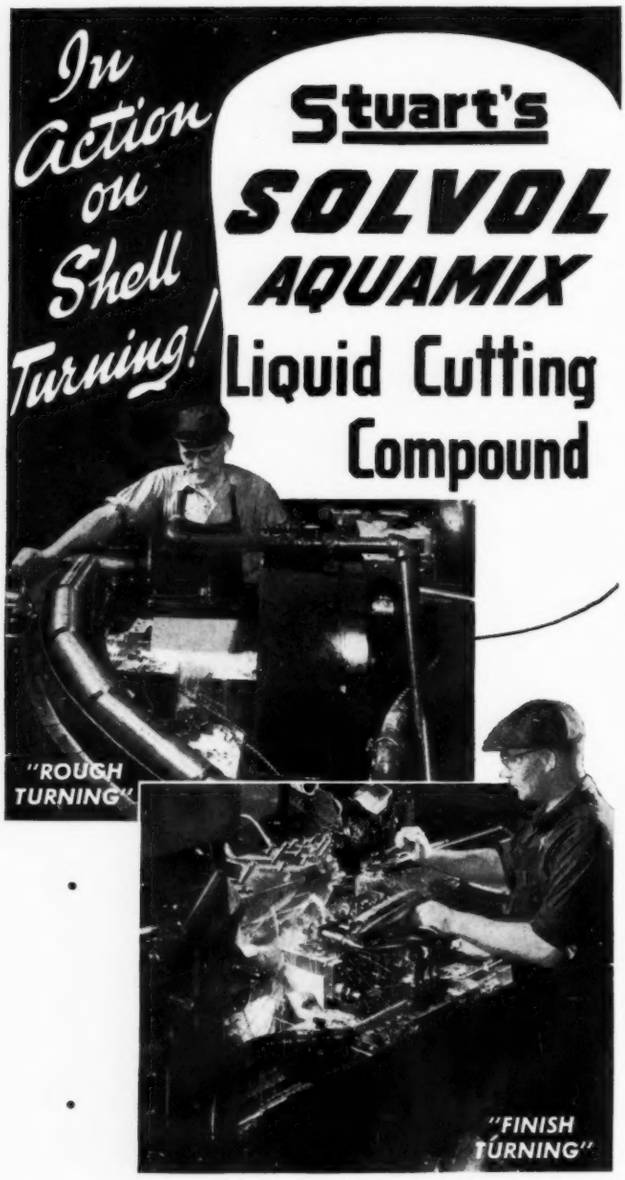

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Book Reviews

automatic rifle and the light machine gun both have bright futures in store.

The second point involves a realization that many a scientific advance engenders its concomitant drawbacks. Thus Johnson and Haven tell us that since the cost of a new barrel for a light machine gun is no greater than that of 200-300 rounds of ammunition, we had best discard and replace it whenever such action may be indicated, which, under modern battle conditions, would appear to be rather often. Thus (p. 249), "The average light air-cooled barrel will stand over 1,200 rounds at 100 per minute. . . . Ammunition is more profitably expended through a new bore than one which is all burned out."

O tempora! O mores! Twelve hundred rounds forsooth! Black powder may have been dirty, but it possessed at least the virtue of combustion at moderate temperatures as compared with those developed by the smokeless propellants of today. It fouled, but did not destroy. In witness whereof, a single Gatling of caliber .50 (6-barreled) was fired, on October 23, 1873, exactly 63,600 times in a space of less than four hours "without stopping to wipe or clean the barrels. At the close of the firing . . . a very good target was made at 300 yards' range before cleaning the barrels." Imagine firing 10,600 rounds through each barrel in 4 hours, or about 45 per minute per barrel for 240 minutes—and the bores as good as new. Ah, those were the happy days!

CALVIN GODDARD.

ARMY TALK. By Col. Elbridge Colby. Princeton: Princeton University Press. $2.

THIS is not merely a glossary of Army slang as might be suspected, but rather a dictionary of the military language—casual, technical, and official. Derivations and connotations of phrases from "aide-de-camp" to "zombie" are included in a form guaranteed to equip the most civil civilian for conversation with a "refugee" or a general officer. Colonel Colby designates Army slang, distinguished from American slang generally, as that which has originated in or is peculiar to the Army. He is well qualified to make the distinction for, since 1917, he has combined the literary with the military. Here he puts the two to work in his picturesque treatment of that ever-present problem of the soldier's friends and relatives—Army talk. J. C. DUNBAR.

PERCUSSION COLT REVOLVERS: CATALOGUE OF A LOAN EXHIBITION OF PERCUSSION COLT REVOLVERS AND CONVERSIONS, 1836-1873. By John E. Parsons. New York: The Metropolitan Museum of Art. $2.

THE exhibition of Colt revolvers, of which this book is the catalogue, is now being held at the Metropolitan Museum of Art in New York. It began February 4th and will continue to May 3rd. The 130 pistols in the collection—ancestors of the present-day military weapons—date from the year 1836, when Samuel Colt patented the first multifiring arm, to 1872. In the collection are included some twenty different examples of the earliest Colt model, known to collectors as the "Paterson." Among the lenders of rare specimens are Messrs. Edwin Pugsley of the Winchester Repeating Arms Company and Richard D. Steuart of Baltimore, both well-known members of the Army Ordnance Association. Other rare pieces have been loaned by Albert Foster, Jr., Philip R. Phillips, and by Mr. Parsons, the compiler of the catalogue.

Mr. Parsons, in the compilation of this work, was assisted by his daughter, Fanny, and by his secretary, Mary V. Farrell, in verifying details. Edward Milla, of the museum staff, made the photographs with which the catalogue is illustrated. The Wadsworth Atheneum, of Hartford, Conn., also loaned specimens for display in the exhibition.

This volume, in the best tradition of the museum's publications, is timely in bringing to attention the influence of modern industry upon arms development. R. E. LEWIS.

Defense Library

TIMELY BOOKS

THE following books have been added recently to the library of the Army War College, Washington, D. C. They constitute a timely list of texts on various aspects of national defense. ARMY ORDNANCE *acknowledges with thanks the permission of Lieut. Col. R. B. Hough, Jr., librarian, to publish the list.*

Ameel, Joseph.—*Red hell.* London: Hale, 1941. A vivid account of life in the U. S. S. R. The author has spent his life in Russia.

Askins, Charles.—*Art of handgun shooting.* New York: A. S. Barnes, 1941. Written for both beginner and expert. Methods outlined are those which the author has used in winning at one time or another practically every worth-while championship.

Barres, Philippe.—*Charles de Gaulle.* New York: Doubleday, Doran, 1941. An authoritative account of the Free French movement and its leaders.

Basch, Anton.—*New economic warfare.* New York: Columbia University Press, 1941. An eyewitness account of the way in which Germany manipulated the trade and politics of other countries for the purpose of strengthening her own position and weakening theirs.

Belperron, Pierre.—*Maginot of the Line.* London: Williams & Norgate, 1940. The first English biography of André Maginot. Part 2 contains a short up-to-date description of the Line and life in it, based on material supplied by the French Military Mission.

Blech, William James.—*The Copperheads.* New York: Dial Press, 1941. Story of the first organized fifth column in America.

Brooks, Geoffrey.—*Brotherhood of arms.* London: Clowes, 1941. The author's reminiscences of the brighter side of the war of 1914-1918 in France.

Buckland, Charles Stephen.—*25th army brigade R. G. A. on the Western Front in 1918.* London: Blackwell, 1940. British regimental histories covering the first German war have few counterparts concerned with artillery formations.

Carroll, Mary Tarver.—*The man who would not wait.* New York: Longmans, Green, 1941. The author has made full use of Aaron Burr's headstrong character in telling the story of his life.

Carter, Albert E.—*Battle of South America.* Indianapolis: Bobbs-Merrill, 1941. The Battles of France, Britain, Greece, Russia, all have meant much to us—but the Battle of South America may mean most of all.

Catling, Skene.—*Vanguard to victory.* London: Methuen & Co., 1940. An account of the British expeditionary force during its first months in France in the second great war.

Chesney, Clement Hope Rawdon.—*Art of camouflage.* London: R. Hale, 1941. Most readers, whether they be amateur or professional, will find a great deal to interest them in this comprehensive and concise work on a specialized art, an art which has once more come into its own.

Chickering, William H.—*Within the sound of these waves.* New York: Harcourt, Brace, 1941. Story of the people of Hawaii from the days when the first Polynesians ended their long voyages on Hawaiian shores up to the comparatively recent period when the first American missionaries established residence.

Clarke, Thomas Wood.—*Émigrés in the wilderness.* New York: Macmillan, 1941. The romantic and little-known stories of the well-to-do French families who fled to this country when their lives were imperiled by the Revolution and Napoleon.

Cox, Geoffrey.—*Red army moves.* London: Gollancz, 1941.

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Craine, Eugene R.—*The story of Fort Roberdeau, 1777 to 1783.* Altoona: Tourist and publicity bureau of the Chamber of Commerce, 1941. Story of the fort commonly known as the Lead Mine Fort, with a biographical résumé of the life of Daniel Roberdeau.

Cromwell, James H. R.—*Pax Americana—American democracy and world peace.* Chicago: Kroch, 1941. Author sets forth the reasons why he believes that permanent peace in the world cannot be secured without the active participation of the U. S.

Czechoslovak Republic. Ministerstvo Zahranic-Nichveci.—*Two years of German oppression in Czechoslovakia.* London: Czechoslovak ministry of foreign affairs, department of information, 1941. A carefully documented account of what has happened to Czechoslovakia since is was violently incorporated into the Third Reich.

Dame, Lawrence.—*Yucatan.* New York: Random House, 1941. A blending of travel narrative and serious study of a little-known tropical region.

Darton, Andrew W.—*Citizenship in war time.* New York: Fortuny's, 1940.

Donahue, Arthur Gerald.—*Tally-ho! Yankee in a Spitfire.* New York: Macmillan, 1941. Personal story of the Minnesota farm boy who was the first American to see combat with the R.A.F.

Dos Passos, John.—*The ground we stand on.* New York: Harcourt, Brace, 1941. A study of the early influences which formed American life.

Downey, Fairfax.—*Indian fighting army.* New York: Scribner, 1941. An exciting and richly episodic running panorama of the western Indian wars, as seen through the eyes of the soldiers who fought them.

Ehrlich, Leonard.—*God's angry man.* New York: Press of the Readers Club, 1941. The story of a man of great stature (John Brown) who falls because of a fatal defect of character—the defect of fanaticism.

Fairgrieve, James.—*Geography and world power.* New York: Dutton, 1941. Author's thesis is that history has been controlled by geography, and that the geographical situation and characteristics of a country dictate, within certain limits, its influence and its action on the world.

Falls, Cyril Bentham.—*Nature of modern warfare.* London: Methuen, 1941. While the aim of the author is to throw light upon modern land warfare, the rôle of aircraft in coöperation with ground forces is also discussed, and there is consideration of the influence of sea power upon armies in the field.

Fast, Howard.—*Last frontier.* New York: Duell, Pierce and Sloan, 1941. A story of the old West that is new and exciting.

Finland, Ministeriet for Utrikesarendena.—*Finland reveals her secret documents on Soviet policy, March 1940-June 1941.* New York: Funk, 1941. Official Blue-white book of Finland. Shows, through official documents, how Finland was again dragged, step by step, into war with Russia.

Glick, Carl.—*Shake hands with the dragon.* New York: McGraw-Hill, 1941. Friendly and interesting account of the customs and philosophy of the Chinese in America.

Glover, Charles William.—*Civil defense.* London: Chapman & Hall, 1941. A practical manual presenting with working drawings the methods required for adequate protection against aërial attack.

Grenfell, Russell.—*Sea power.* New York: Doubleday, Doran, 1941. A brilliant and original treatment of the subject. Author has profound knowledge of British maritime history.

Great Britain Air Ministry.—*Bomber command.* New York: Doubleday, Doran, 1941. The Air Ministry account of bomber command's offensive against the Axis, September 1939-July 1941.

Hahnel, Robert.—*Man power, U. S. A.* St. Louis: League of Draftable Men, 1941. A draftable man's balance sheet of conscription.

Hamilton, Mary Agnes.—*Women at work.* London: Routledge, 1941. A brief introduction to trade unionism for women.

Harris, Seymour E.—*Economics of American defense.* New York: Norton, 1941. Aims to contribute to the solution of the many vexing economic problems that confront our country in the present emergency.

Hermer, Mrs. Consuelo (Kamholz).—*Havana manāna.* New York: Random House, 1941. A guide to Cuba and the Cubans.

Herring, Edward Pendleton.—*The impact of war.* New York: Farrar & Rinehart, 1941. Our American democracy under arms.

Howard, Helen Addison.—*War chief Joseph.* Caldwell: Caxton printers, 1941. Here, for the first time, the great Nez Percé emerges in photographic reality, for the authors have spent years of research before writing their book.

Hrushevsky, Michael.—*A history of Ukraine.* New Haven: Yale University Press, 1941. Meets a vital need for an authoritative work in English on the main developments in the history of Ukraine, a country whose centuries-old struggle for independence is beginning to have an important bearing on the course of European events.

Knickerbocker, Hubert Renfro.—*Is tomorrow Hitler's?* New York: Reynal & Hitchcock, 1941. Two hundred questions on the battle of mankind. Few men in this country are as well equipped to answer them as is the author.

Koestler, Arthur.—*Scum of the earth.* New York: Macmillan, 1941. The author, a private in the British Army, recounts his experiences in Le Vernet, worst of the French concentration camps.

Koeves, Tibor.—*Satan in top hat.* New York: Alliance Book Corporation, 1941. The biography of Franz von Papen.

Kovacs, Frederick W. L.—*The untamed Balkans.* New York: Modern Age Books, 1941. A terse history of this "precarious peninsula" that always has been the powder keg of Europe.

Lengyel, Emil.—*Dakar.* New York: Random House, 1941. Almost a textbook. Should be useful to all Americans in the coming days.

Levy, Roger.—*French interests and policies in the Far East.* New York: Institute of Pacific Relations, 1941. A study of the cultural traditions of France in China and Japan and the trade relations of France and Indo-China with China, Japan, Siam, the Malay States, Australia, and New Zealand. Clarifies for the student of world affairs the obscurities of the situation as it exists today.

London Fire Brigade.—*Fire prevention hints.* London: London County Council, 1940. The object of this book, based as it is on actual fire-brigade experience, is to enable the London public to gain this knowledge and so to render itself more secure.

Major, Ralph Hermon.—*Fatal partners, war and disease.* Garden City: Doubleday, Doran, 1941. Doctor Major follows the sweep of battle across the continents of the world as the victory or defeat of armies pales into insignificance before the onslaught of diseases which met them and pursued them home.

Mannheim, Hermann.—*War and crime.* London: C. A. Watts Co., 1941. Studys of the analogies and contrasts between the causes of war and of crime.

Marshall, Samuel Lyman Atwood.—*Armies on wheels.* New York: Morrow, 1941. The significant campaigns since Dunkerque, with particular emphasis on what they teach us about the "ideal army" for the offensive and defensive modern war.

Milton, George Fort.—*Conflict—the American Civil War.* New York: Coward-McCann, 1941. First-rate history of the Civil War. Good to read even in the midst of another great war.

Moss, James A.—*The flag of the United States, its history and symbolism.* Washington: The United States Flag Association, 1941. The author, probably our most noted authority on the American flag which he has followed on the battlefields of three wars, has produced here an exceedingly timely publication.

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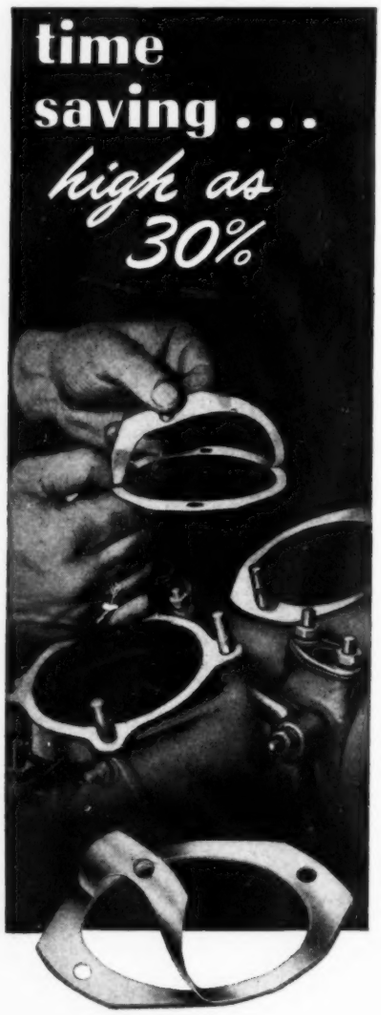

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Neilson, William Allan.—*We escaped.* New York: Macmillan, 1941. Twelve refugees tell exactly what happened to them when their various countries were taken over by the Fascist powers.

Nelson, Douglas H.—*Glossary of aëronautical terms.* Brooklyn: Chemical Publishing Co., 1941. This authoritative compilation of definitions is in conformity with Air Ministry recommendations and requirements.

Pfeiler, Wilhelm Karl.—*War and the German mind.* New York: Columbia University Press, 1941. What the Germans have thought about war for a generation or more. Despite the feelings of writers such as Remarque and Zweig, if Germany had won in 1918, she would have climaxed her victory with the establishment of totalitarianism.

Ray, Ermin Levi.—*Are you fit to be a pilot?* New York: Funk, 1941. With this unique book it is possible to answer the burning question of the youth of America—and many adults as well—"Am I physically fit to be a pilot?"

Reimann, Guenther.—*Myth of the total state.* New York: Morrow, 1941. An analysis of the limitations of European Fascism as a lasting force in world affairs.

Ricci, Lewis Anselm da Costa.—*Action stations!* Boston: Little, Brown, 1941. Short stories of the British fleet during the present war, by a British naval officer.

Richey, Paul.—*Fighter pilot.* New York: Scribner's, 1941. How warplane pilots think, feel, and act in the moment of combat is excitingly revealed in this unusual book.

Richmond, Sir Herbert William.—*Invasion of Britain.* London: Methuen & Co., 1941. Outlines the various schemes for the invasion of Great Britain, either projected or actually attempted, from Queen Elizabeth's day to the war of 1914-1918, and the naval and military measures taken to defeat the attempts.

Robert, Karl (psued.).—*Hitler's counterfeit Reich.* New York: Alliance Book Corporation, 1941. The author, an economic expert who only recently has come to this country from Vienna, lived for years behind the scenes of Nazi economy.

Roethlisberger, Fritz Jules.—*Management and morale.* Cambridge: Harvard University Press, 1941. Students of social conditions will have a special interest in this book because it resolves the conflicts between schools of thought which have hindered so long the development of scientific knowledge.

Russell, William.—*Berlin embassy.* New York: Dutton, 1941. A clerk in the American embassy writes of daily life. He tells something of what Germany looked like in the months immediately before and after the outbreak of war.

Schurz, William Lytle.—*Latin America.* New York: Dutton, 1941. The author has had a wide first-hand acquaintance with Latin-American life. He gives us an expert account of our neighbor-culture to the south.

Sforza, Carlo.—*The totalitarian war and after.* Chicago: University of Chicago Press, 1941. A new light shed on the intricacies of the European strife by the former Italian Foreign Minister, now in voluntary exile.

Simpson, J. S. M.—*South Africa fights.* London: Hodder & Stoughton, 1941. Gives some idea of the magnitude of South Africa's effort, from the state of unpreparedness in September 1939 to the triumph of today when she has put a complete army into the field.

Spaight, James Molony.—*Battle of Britain, 1940.* London: Bles, 1941. Describes the German air attack on Great Britain which began on June 18th and reached its climax on September 15th.

Storrs, Sir Ronald.—*A record of the war: The first quarter, September-November 1939.* London: Hutchinson & Co., Ltd., 1940. The first in a series of four volumes on the first year of

the war. Deals with every aspect of the war and its causes.

Strong, Anna Louise.—*The Soviets expected it.* New York: Dial Press, 1941. The author gives her frank opinion of Hitler's chances of conquering Russia.

Sundquist, James.—*British cities at war.* Chicago: Public Administration Service, 1941. Written to indicate the effect of active warfare on British cities. Complete story of air-raid organization in British cities.

Thomas, Harlan C.—*A Yank in the R. A. F.* New York: Random House, 1941. The story of one cocky young American eagle who couldn't wait for Congress to make up its mind and joined the R. A. F. in Britain.

Torres, Henry.—*Pierre Laval.* New York: Oxford University Press, 1941. A biography and character study of Laval, who, the author contends, is still the real power behind the political scene in France, representative of Hitler's "new order."

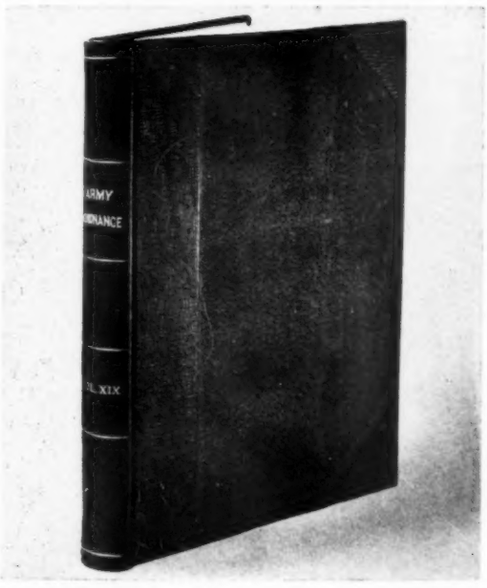
Vandenbosch, Amry.—*The Dutch East Indies.* Berkeley and Los Angeles: University of California Press, 1941. This work, out of print for several years, has long been held in high esteem for its balance, accuracy, and comprehensiveness.

Van Passen, Pierre.—*That day alone.* New York: Dial, 1941. The author explores the mystery of man and tells of the human drama behind the titanic events of our day.

Viereck, Peter.—*Metapolitics, from the Romantics to Hitler.* New York: Knopf, 1941. This book is an attempt to know, by its historical and psychological roots, that religion called Naziism which is now so fanatically menacing the ideals and the lives of the free peoples.

Vollmer, Arthur.—*How to become an officer.* New York: Hastings House, 1941. Covers the "How to become" and purposely excludes everything on "How to be" an officer after becoming one.

Walton-Kerr, Philip St. C.—*Gestapo.* London: Hale, 1940. Authentic account of one of the most dangerous organizations ever created by human ingenuity.



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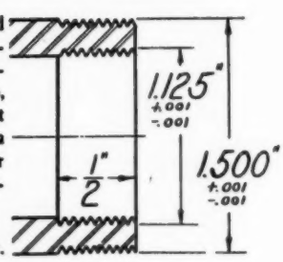

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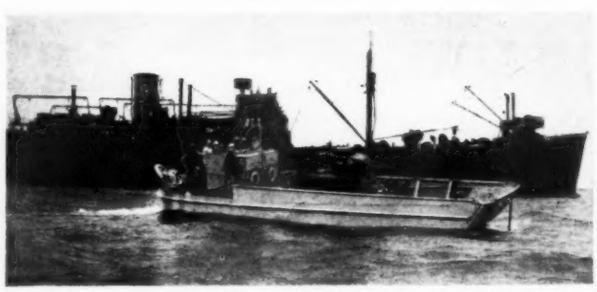

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Volume XXII | MAY-JUNE, 1942 | No. 132

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(Publication date: April 26, 1942)

Published by the Army Ordnance Association, Suite 705, Mills Building, Washington, D. C. Editor: Lieut. Col. L. A. Codd, Ord. Res.; Associate Editor: R. E. Lewis, Jr. Authors are responsible for statements and opinions expressed in their articles. Copyright, 1942, by the Army Ordnance Association, Washington, D. C. Permission for republication in whole or in part must be obtained in advance.

Issued bimonthly. Single copy 75c (by mail). Subscription rate: continental U. S. and possessions, $4.50 annually, in advance. Entered as second-class matter, August 14, 1920, at the Post Office at Washington, D. C., under the Act of March 3, 1879. Additional second-class entry at the Post Office at Richmond, Va. Three weeks' notice before publication date of next issue required for change of address.

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THE Army Ordnance Association, a national society of more than 10,000 American citizens, was founded in 1919, "pledged to industrial preparedness for war as our nation's strongest guaranty of peace." The society was incorporated under the laws of the District of Columbia in 1928. Its entire energies are now dedicated to victory for the armed forces of the United States. For the duration of the war it is "pledged to victory—complete, absolute, final."

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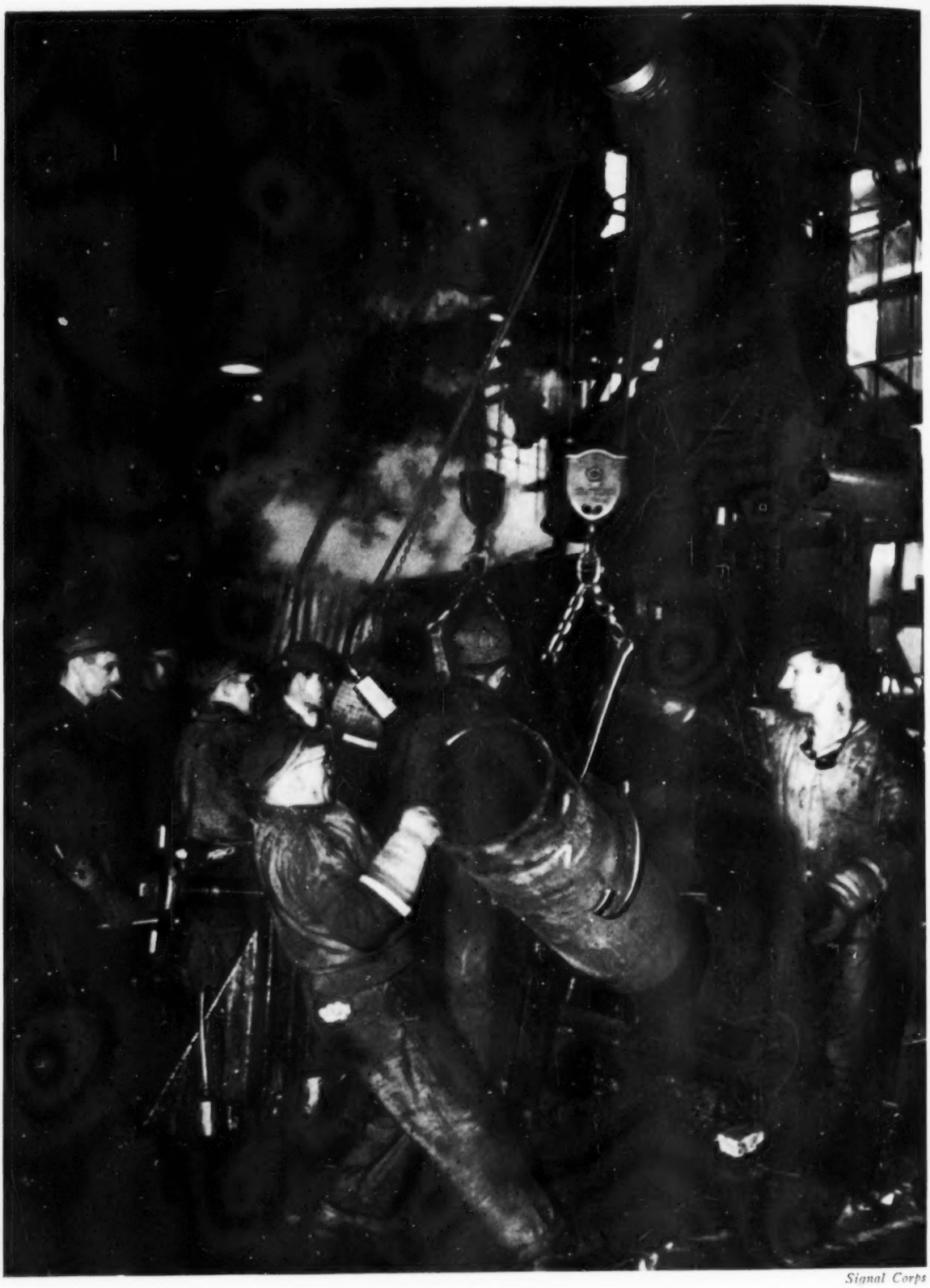

Signal Corps

Bomb Making

ARMY ORDNANCE

Volume XXII MAY-JUNE, 1942 No. 132

Ordnance in My Time

A Review of American Military Armament Since 1900

Maj. Gen. C. M. Wesson*

IT IS with a profound feeling of the seriousness of the times that I appear before you tonight to speak on American ordnance—a theme of the widest historical significance. In far less congenial surroundings than these, the Latin poet, Vergil, began his triumphant ballad in words well known among all classical scholars, "I sing of arms and the man." Since then, every generation of virulent men, either at peace or at war, has returned to that theme in praise of the arms and the men who wield them—but less frequently of the men who make them.

Some months have passed since I accepted the invitation to deliver this Newcomen address. My acceptance was given when our country was at peace, and it was the desire of your committee that I speak to you on the historical evolution of American military armament as embraced in the term "ordnance." It was indicated further by your committee that I should describe for you some of my contacts with ordnance progress and some of the principal developments which have characterized American ordnance since 1900, the year I was graduated from the Military Academy at West Point, until this very day. This honored invitation I was delighted to accept. But the urgency of the times since the invitation was accepted has prevented me from preparing the full historical résumé I had at first intended to present.

In Newcomen we have discussed economics, communications, finance, industry, transportation, banking, utilities, and the law. These are fitting topics because all are forces which contribute mightily to the progress of mankind. But now we have come upon evil days—days of great suffering and of greater heroism. Well may be included, then, among Newcomen's discussions, this subject on which I am to speak, namely, ordnance. For the weapons which we are now forging are the very life blood of the United States. Weapons are the bonds of brothers in battle. In that relationship now stand the United States and Great Britain—a relationship which Newcomen does well to foster.

I have divided the subject, "Ordnance in My Time," into three more or less distinct phases: The first phase will embrace a discussion of the ordnance with which the American Army was equipped at the time I joined it as a second lieutenant in 1900. The second phase embraces the developments in arms which took place during the period 1900 to 1918. The third phase will cover the developments of ordnance during the period 1919 to 1942.

Let us return to the days of peace in 1900. At that time, the Ordnance Department of the Army already had behind it a long and distinguished history. The Department had played a greater part in the affairs of our country than is commonly appreciated by our citizens. It was formed as a separate entity in the year 1812 (actually, May 14, 1812) but it really has functioned since Revolutionary times. The Department made great contributions in the American Civil War. Throughout its history, the Ordnance Department has continued to strive for the development and perfection of weapons—a noble endeavor always.

OUR weapons of forty years ago are crude when viewed in the light of our present designs. But so also are all classes of machines of that time when looked at from the vantage point of our streamlined, effort-saving devices of today. Such comparison casts no aspersion on the fine engineering talent and productive ingenuity of the personnel in the Ordnance arsenals and laboratories and in American industry at the turn of the century. The industrialization of the United States, then coming to its adolescent years, was as apparent in the six arsenals of the Ordnance Department as it was in the plants and factories of our then-youthful peace-time commercial industry.

The Ordnance Department's arsenals were of great aid, even in the year 1900. These depositories of the armorer's art already had come through long and trying periods of war and peace. The Springfield Armory in Massachusetts had been planned by George Washington, the Father of our Country, and was actually started as a powder depot in 1777. The Watertown Arsenal, also in Massachusetts, had long since taken its rightful place as an establishment for the production of cannon. The Marquis de Lafayette, heroic Franco-American patriot, had visited the Watervliet Arsenal in New York soon after its establishment. The Rock Island Arsenal in Illinois, once an Indian outpost and, prior to the Civil War, a station where Abraham Lincoln served, had become, coincident with the American Civil War, an arsenal which then ranked among the greatest of arms producers in the world. Two others, the Frankford Arsenal in Pennsylvania and the Picatinny Arsenal in New Jersey for the development and production of ammunition and its components, likewise shared in the industrial and engineering development of the times and applied those developments to the things of war.

I mention these Ordnance establishments as being a part of the industrial growth of the United States. They are definitely that. As the arsenals benefited by the developments in production technique and the engineering of a peace-time economy and applied those developments to our weapons, so also did the arsenals share with the peace-time economy of the nation all the basic armament researches, many of which have had revolutionary effect in the fields of metallurgy, elec-

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An address before the Newcomen Society of England, American Branch, at the University Club, New York City, April 23, 1942.

tricity, and aëronautics. How broad this relationship is, the pages of history give abundant evidence.

In 1900, when I entered the Army, there were but 2,447 officers and 29,000 men in the entire military establishment. The Ordnance Department itself was composed of a group of 67 officers and 605 enlisted men, civilians, and engineers. The attitude of the people toward armament was at best parsimonious or perhaps skeptical—or possibly I should say disinterested. General Crozier, who became Chief of Ordnance in 1901, repeatedly warned the American people of the unpreparedness of the nation and requested Congress year after year for adequate appropriations for weapons and ammunition. His pleas were, in general, unheeded.

Nevertheless, the Department made important progress within the limits of its appropriations, which were largely for seacoast armament. These defensive weapons, which outclassed those of any other nations, were installed under the policy that this country might be called upon to defend itself from an invader. Eventually our principal harbors became well armed with powerful guns mounted on disappearing carriages. But, with the exception of the 3.2-inch field gun and a few other calibers, it had been impossible for the Department to secure funds to design and build larger mobile weapons. Our people were in one of their periodic "no-more-war" humors.

WE possessed a few hundred field guns and also a small number of 5-inch siege guns and 7-inch howitzers. All these weapons had trunnions secured directly to the carriages, and the shock of recoil was taken up by the movement of the carriage to the rear with each shot. Each round fired generated a large volume of black smoke. The rate of fire was necessarily very slow. About 1902, the Department initiated experiments with different types of recoil mechanisms which permitted the use of stabilized carriages and by 1917 had developed and produced a small number of field guns and howitzers embodying this principle.

During the years prior to the World War, development of the machine gun was most active. The interest of our combat arms in the machine gun, however, was divided. The weapon was difficult to keep in adjustment and required the frequent services of skilled mechanics. Many people thought that it lacked the reliability so necessary for a successful weapon and questioned whether it could be kept supplied with ammunition. The famous Browning machine gun, which in principle still remains standard and is recognized as the world's best, was produced in great quantities during the first World War to meet the tremendous demand for this type of weapon. Our bolt-action, clip-fed shoulder rifle, known as the Springfield, model of 1903, has been acclaimed throughout the world as a single-shot shoulder rifle unequaled to this day.

When war engulfed Europe in 1914, agents of the Allied nations appeared in this country seeking commercial concerns to accept orders for large quantities of foreign-designed matériel. Many leading American companies accepted large orders, and in this way a very sizable munitions industry was built up where practically none had previously existed. One of the larger contracts was with the Remington Arms Company for the manufacture of the English Enfield rifle. A large plant was built by the company which was later utilized by the United States after its entrance into the war for the manufacture of the American Enfield rifle.

This same practice was followed for many types of artillery, such as the British 8-inch and 9.2-inch howitzers. However, up to the time the United States declared war against Germany in April 1917, no appreciable appropriation had been made by the Congress for augmenting ordnance equipment for the United States Army. The Ordnance Department, however, immediately undertook a great program for the manufacture of ordnance. It was proved then, as was previously contended by our Ordnance officers, that troops could be trained more quickly than the ordnance necessary to equip them could be produced. It therefore became necessary to purchase large quantities of arms and ammunition from England and France. Luckily, these countries had been at war sufficiently long to enable them to supply this material to us from their own production surpluses.

To conserve time under the conditions of great danger which then existed and also to secure the benefits of interchangeability of parts, the wise decision was made to adopt as far as possible French calibers and designs of artillery and other weapons, retaining only such of our weapons as the Springfield rifle, the Browning machine gun, large-caliber guns, and other well-developed items of American ordnance. While it is true that little ordnance of American manufacture reached the fighting front in 1918, production initiated during the war was continued after the Armistice, and, in this way, an adequate stockpile of ordnance was created which gave our country munitions security for at least the following 15-year period.

The Ordnance effort of the World War, from a dollar standpoint, attained a total undreamed of prior to that time. That program reached into thousands of our private manufacturing plants and—then as now—required the erection of vast special facilities. After the Armistice of November 1918, and over the protest of the Ordnance Department, many of these special factories were scrapped. Would that they had been kept in a stand-by and modernized condition for the needs of today! But again a "no-more-war" humor infected the body politic.

AFTER the Armistice, the Ordnance Department undertook a new and broad development program in order to take full advantage of the basic lessons learned on the battlefields of Europe. This development has continued steadily and without interruption. It was restricted severely during the 1920's because of small appropriations and the lack of interest in any kind of preparedness by the majority of our people. We of the Ordnance Department fully realized that few, if any, of the weapons of 1918 would be suitable for the new types of warfare which had been developing in the minds of military men throughout the world. Just as the automobile of 1918 bears little resemblance to or has little in common with the streamlined models of today, so the weapons of 1918, with few exceptions, could not be employed successfully on today's battlefields.

One of the far-reaching phases of this postwar period of preparation for future wars was the development of the so-called Ordnance district system of decentralized procurement. During the latter part of the World War, the Ordnance program was slowing down because of the centralized method of procurement then in effect. A decentralized system was set up under which procurement was apportioned to fourteen Ordnance districts. These districts covered the entire country, their areas varying with the amount of industry located within their boundaries. The districts were reactivated shortly after the World War and have been in

operation continuously since that time. An experienced Ordnance officer was detailed to each district headquarters, and a prominent civilian, well known in the industrial life of the region, was selected as district chief. The district chiefs patriotically served without compensation. Their Regular Army executive officers set up tiny organizations consisting of from one to two clerks and advisory engineering and industrial groups. These officers undertook a detailed survey of the principal industrial plants lying within their district confines and selected those plants best qualified for the production of specific types of ordnance matériel. Thus the entire Ordnance war-time load as estimated was allocated to individual private producers.

DURING the first World War, one of the serious difficulties encountered was the fact that orders were placed with many companies for weapons or parts of weapons which the companies were not properly equipped to produce. Under the district planning system, it was possible to search out companies best qualified to produce certain definite classes of ordnance equipment. In this way, approximately 15,000 plants throughout the United States were surveyed by the Ordnance districts and selections made of those best adapted to manufacture the various types of ordnance with least transformation of plant. The companies so selected worked out production plans in conjunction with our District offices and without compensation. They studied the drawings and specifications and in many cases made factory layouts of machinery. It is worthy of note that, in the present emergency, the Ordnance Department turned first to these surveyed and allocated facilities. Some eighty-four per cent of these same allocated manufacturers now have orders with the Department under the present great munitions program.

When I became Chief of Ordnance in June 1938, I found the Department soundly organized for either peace or war. In the tremendous expansion which the Department has undergone during the past four years, the basic organization has remained unchanged. The general plan of procedure evolved during the planning years has been followed almost verbatim. With war clouds gathering in Europe, it was not difficult to foresee that another great conflict was in prospect, and the Department immediately set to work with vigor to put its house in the best possible order for the coming crisis.

Luckily, our citizens were becoming alarmed over the prospect of another European war with the possibility that this country might again be drawn into the maelstrom. Appropriations for the Ordnance Department for the period 1918 to 1938 averaged only $12,000,000 a year. In 1938, the Congress appropriated $25,000,000, and this was followed by an appropriation of $112,000,000 for the fiscal year 1939. The first large emergency appropriation for Ordnance became available in September 1940. This appropriation amounted to $1,500,000,000, and the Department at once put its industrial-mobilization plan into effect. Under the plan, the Ordnance districts were placed on a war footing, and steps were taken to increase their personnel. This building up of the districts' personnel is still in progress, keeping step with the ever-expanding load. Since that first emergency appropriation, the load has been continuously increasing until today Ordnance appropriations for this emergency amount to over $23,000,000,000, or over four times that of the World War. I cite this figure only as an indication of the size of the Ordnance task in this war effort.

Fortunately, indeed, the great majority of the new weapons of warfare required had been developed during the years preceding the emergency. Thus, the Department was in a position to place orders immediately with industry and to supply industry with the necessary drawings and specifications. In some cases, however, designs of certain types of new matériel were lacking, as insufficient funds had been made available to make possible their design and development. This condition applied particularly to the more expensive types of weapons such as heavy tanks and large-caliber artillery. When funds became available, however, an intensively active research and development program was undertaken by the Department in order to take care of these known deficiencies in our matériel and, at the same time, to develop new and previously unknown weapons.

Under the extremely limited peace-time appropriations, it had been necessary to carry out a great deal of our research and development work at the Government arsenals. However, it was fully appreciated that the rather limited personnel in my Washington office and at the arsenals would be insufficient to carry the heavy load of a large development program under war conditions.

Consequently, early in my tenure I adopted the policy of going into partnership with American industry on an accelerated research and development program, utilizing the outstanding personnel and facilities of private industry in coördination with the trained Ordnance personnel. This partnership has proved to be a very happy one indeed, in that commercial companies, under the guidance of our experienced officers and engineers, have been able to produce quickly these new required types even though such companies and their highly competent engineers have had no previous experience in such work.

THE Department now has before it hundreds of examples of successful models of new matériel which have been produced by the joint effort of American industry and the Ordnance Department. These new types include a great variety of matériel and cover all phases of Ordnance work: small-arms weapons of various types—such as the new carbine—new types of small-arms ammunition, many new types of artillery, including the heaviest type of field howitzer, advanced types of antiaircraft guns, fire-control instruments, fuzes, new types of tanks, armored cars, and so on.

I should like to cite a few examples of these new Ordnance weapons. Starting some twenty years ago, the Department undertook the development of a new type of shoulder rifle, now known as the Semiautomatic Rifle, M1, or more popularly as the Garand rifle, after its inventor. Today, this rifle is under quantity manufacture and surpasses all others in the military field. Just a few weeks ago came the Garand's crowning glory—it had met the test of actual battle and at the hands of one of the greatest American heroes of all time —Gen. Douglas MacArthur. From that sterling soldier I received a message sent from the fastnesses of Bataan saying that the Garand is excellent without any modification in its parts or assembly and that in actual combat service this semiautomatic rifle has proved itself superior to the older Springfield.

The Department has taken the lead in the development of speedy tanks of great fire power. Our light tanks have already proved themselves on the battlefields of Libya and have been found to be superior in their weight class. Our American tank has been unofficially designated by the Brit-

ish Tommy as the "honey." Our new medium tanks are now arriving in volume in several foreign theaters and doubtless will soon receive their baptism of fire. These tanks with their great fire power likewise have outstanding characteristics.

Today, the United States Army possesses one of the finest systems of artillery in existence. This system includes the required types of artillery from the mountain through the division, corps, army, and GHQ artillery. In evolving this system we have borrowed freely from foreign countries.

It is the policy of the Department, whenever a foreign weapon has been found superior, to secure that foreign weapon if possible and to place it on our list of accepted types. Thus, at the present time, we have several types of foreign equipment on our ordnance list. In the field of artillery ammunition, the Ordnance Department worked out some years ago a universal fuze system which permits practically all types of fuzes to be used interchangeably for different calibers, thus simplifying the ballistic problems involved. In the field of exterior and interior ballistics, the Department has maintained a trained staff of ballisticians who have kept well abreast in this important field of endeavor. Modern warfare is extremely complicated, and simplicity in the tools of war is no longer possible.

THE six manufacturing arsenals of the Department have played a vital rôle in the conversion of private plants to the production of ordnance. When the emergency started, the doors of the arsenals were thrown open to all manufacturers. Each arsenal is a technical center of knowledge for certain items or groups of items. The Department's policy has been not to restrict a manufacturer in any way as to method but rather to provide him with every help in the nature of working drawings and specifications and permit him to study how this item or a similar item was produced at one of the arsenals.

Further to assist manufacturers, engineering advisory committees were organized to cover all classes of ordnance matériel. Thus, a tank committee was formed consisting of representatives of all the manufacturers of tanks, together with qualified Ordnance officers and engineers. Some twenty-five of them have now been functioning since October 1940.

It was well known to the Department that certain types of manufacturing plants required for ordnance had no counterpart in the commercial field and that special manufacturing facilities would be required for a large war effort. Our post-war plans revealed inadequate facilities for the manufacture of small arms and small-arms ammunition, smokeless powder, TNT and DNT, anhydrous ammonia, toluol, dimethylamine, diphenylamine, etc., and, of course, a total lack of ammunition-loading facilities. It became necessary, therefore, to provide new plants to offset this inadequacy.

Today, the Ordnance Department has under construction or in production 35 powder, explosives, and pyrotechnic plants, 3 ammunition proving grounds, 25 ammunition-loading plants, 2 gun plants, 3 tank and combat-vehicle plants, and 14 small-arms ammunition and machine-gun plants. This new facilities program will cost in the neighborhood of $3,500,000,000 and this figure does not include the cost of production orders already placed with a great many of the plants. A large number of the new facilities are now in full operation, and each month finds added plants producing much-needed munitions of the types which could not be placed with the existing facilities of American industry.

Throughout the planning years and the years of this emergency, we have been in the closest coöperation with the nation's great research and engineering bodies. Our American engineering brain power has been coördinated with the Ordnance effort. We are now and have always been in intimate coöperation with the vast forces of American industry. I can assure you that industry now, as at every moment of the past twenty years, is giving us the highest degree of cooperation on drawing board, in factory, and in executive office. The volume of armament production now coming from the lines and the volume to be reached shortly combine to create a weapon strength for our country which no power or combination of powers in the world can exceed. Suffice it to say that in both quality and quantity the Ordnance effort at this moment is reaching the culmination of the labors of the past forty years.

WHEN I entered the Department, it was possible for an Ordnance officer to be an expert in all types of matériel. Today, it is necessary that officers spend their entire active lives specializing in certain fields of ordnance, such as the design and manufacture of artillery, automotive fighting equipment, ammunition, explosives, or small-arms weapons. Throughout my career in the Department, it has been a service which has possessed a great *esprit de corps*. Its officers and civilian engineers have been carefully selected and rigidly trained. Its district chiefs and their associates have been men of vision and great capacity. Its advisory committees and consultants from commercial life have been outstanding citizens. All have given of their best. The Department in my time has had the benefit of great leadership and, in two instances, of inspired leadership. I refer particularly to Maj. Gen. William Crozier and Maj. Gen. C. C. Williams. At their feet I learned as much about ordnance engineering and ordnance administration as it was possible for me to absorb.

This, then, is a streamlined, war-time version of ordnance in my time. At another Newcomen meeting when America and Britain shall abide in victorious peace, let us hope that another speaker may be permitted to give you a less circumscribed and a more objective account of so stirring a subject. This much I can say in the fullness of a heart that has been devoted to American ordnance through the forty years I have described all too briefly: The United States and Great Britain are now paying in blood, sweat, and tears the price of their disregard of their military armament in a day when their respective ordnance and industrial authorities were urging at least a reasonable amount of weapon development and production. I am tempted to fear, however, that when this present holocaust is finished and the complacency—not to say the self-sufficiency—of victory and peace come again, the same disregard and misunderstanding of armament will return, unless thinking men and women know and courageously adhere to the simple truths of armament preparedness. In fundamental understanding of that phase of national defense, I am sure that American Newcomen will not be found wanting, nor, let us devoutly hope, will the rank and file of our people in the United States, in England, and throughout the commonwealth of nations.

For the days to come and through many generations, our united duty is best described in the words of the immortal Shakespeare whom I dare to paraphrase:

Come the three corners of the world in arms
And we shall shock them! Nought shall make us rue
If England—and America—to themselves do rest but true.

The New Combat Helmet

Development of a Superior Head Armor for the U. S. Soldier

Col. René R. Studler*

THE Greeks had a word for it, so did the Romans, but to the Army it is just "Helmet, Steel, M1," the most recent offspring of an ancient and honorable lineage and the new helmet recently adopted for U. S. troops.

It is impossible to tell just when or where the first helmet was made, for its origin is lost in the half light of the dawn of civilization. Undoubtedly it was the earliest type of head covering devised. Perhaps the head and skin of an animal, thrown across the shoulders of a Neanderthal man, protected his skull from injury, but whatever the early helmets were, it is certain that by the time Greek civilization had reached its pinnacle, the science of helmet making had developed to a high degree.

The helmets worn by Grecian warriors show clearly the classic lines and functional simplicity of Greek art. Except for the ornamental crest and neck guard, this helmet is the counterpart of those of today. Noticeably absent is the carving and filigree work that characterized helmets of the fifteenth and sixteenth centuries. Only smooth, rounded surfaces are presented in order tc deflect readily any glancing blows. Not only was the Greek helmet sound from a design standpoint, it also was highly efficient ballistically. The following quotation from Homer's "Iliad," illustrates this:

> *Then Peneleos and Lykon, hand to hand,*
> *Engaged in combat: both had missed their aim,*
> *And bootless hurled their weapons; then with swords*
> *They met. First Lykon on the crested helm*
> *Dealt a fierce blow; but in his hand the blade*
> *Up to the hilt was shivered* (Iliad, XVI, 385).

A rough computation indicates the energy expended in such a sword stroke to be of the order of 500 to 800 foot pounds. While it is probable that, in the incident related above, the blow was delivered upon the reënforced crest of the helmet, its ability to shatter a sword must still be considered remarkable, in view of the fact that present-day helmets are only expected to resist a caliber .45 pistol bullet with an energy of approximately 400 foot pounds.

Even in those days, the controversy over the deep helmet versus the shallow helmet raged. The similarity of the winged helmet of Mercury to the British or M1917 helmet is startling. Apparently even the residents of Olympus had difficulty in deciding which type of head covering was the more efficient. Perhaps Mercury, in an effort to achieve the speed for which he is famous, chose the lighter, washbasin type of helmet, and relied upon rapidity of movement for protection!

The Greek civilization, based as it was on a number of independent city states, never really produced anything that could be considered a "typical soldier." It remained for the Romans, with their combination of engineering skill and genius for organization, to weld together an army that did not depend for its unity upon some dynamic leader, disintegrating upon his death like the armies of Alexander the Great. One of the principal factors in preserving the unity of the army during the centuries that Rome ruled the known world was the standardization of equipment. As the borders of the Empire were pushed ever outward, the Roman soldier with his short sword, tunic, shield, javelin, and helmet became the symbol of imperial authority and power from Persia to Britain.

The Roman helmet was essentially modern. Except for the crest and the band across the forehead, it was entirely plain. Originally the band probably was used to give rigidity to the front brim and to prevent the helmet from losing its shape with rough handling, but gradually the band became an ornamental device. It was, in fact, one of the distinguishing features of the Roman helmet. The crest was also purely ornamental—in fact it was removed during battle.[1] Thus, the combat helmet of the Romans was to all intents and purposes the same as a modern helmet. The area of the head covered was about the same as by the M1. No better proof of the excellence of the Roman helmet is needed than the fact that it was used for centuries in all types of warfare with only slight changes. Sometimes a neck guard and face guards were added, but always the basic shape remained the same.

WITH the collapse of the Empire, the perfection attained by the Romans in so many fields of endeavor was either lost or thrown aside, thereby starting, in the case of armor at least, an era of experimentation that has continued until the present. From the fall of Rome until the end of the fifteenth century, the trend was toward ever greater coverage with heavier metal. It is interesting to note that the introduction of firearms into warfare did not immediately make armor obsolete but rather accelerated its development.[2] All through the sixteenth century, the contest of musket ball versus armor continued, with armor gradually losing out during the seventeenth century and disappearing almost completely about the time of the American Revolution.

At all times, the helmet constituted one of the principal pieces of armor and as such was constructed with considerable care and elaboration. In fact a skilled armorer was more artist than blacksmith.[2] Helmets were generally more varied as to types and styles than were complete armor suits. This was probably due to the fact that complete armor was worn only by leaders whose death or serious injury would have meant disaster for entire armies; whereas helmets of one form or another were worn almost universally by common soldiers. The importance of the helmet is even more evident when it is realized that it was retained longer than any other single piece of armor and was the first form of armor to be restored to universal service during the World War.

The entrance of the United States into the World War came with such rapidity that there was no time to develop a helmet of our own even though three years of war in Europe had demonstrated the absolute necessity for some form of protective head covering. The only expedient course

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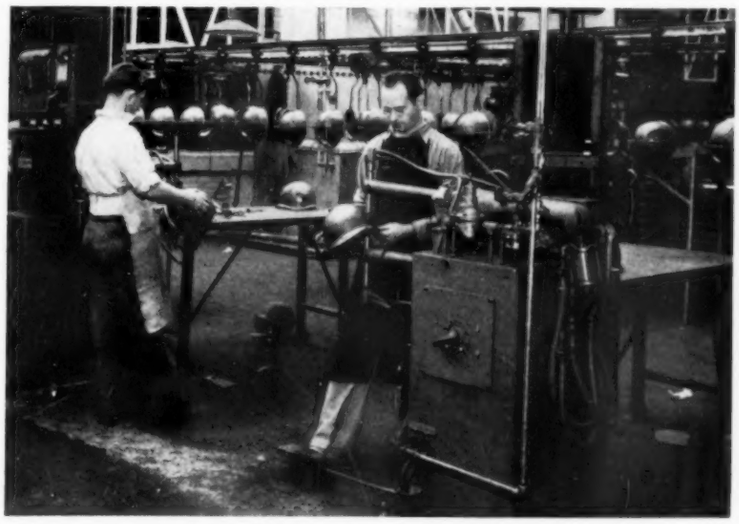
[1] Forestier, Amedee: "The Roman Soldier." [2] Dean, Bashford: "Helmets and Body Armor in Modern Warfare."

United States Helmet, M1

The illustration at the top shows, from left to right, the fiber liner of the new helmet, the football-type suspension, and the steel helmet itself. The center illustrations show back and side views of the liner when worn as a field hat and how the steel shell is placed over it when preparing for combat. The illustrations at the bottom show back, side, and front views of the new helmet as worn over the fiber liner. Note the increased protection this new head armor affords the wearer from all sides, compared with the World War type. The lower center of gravity of the new helmet eliminates much of the rocking movement of the old type. It does not interfere with firing the rifle from any position.

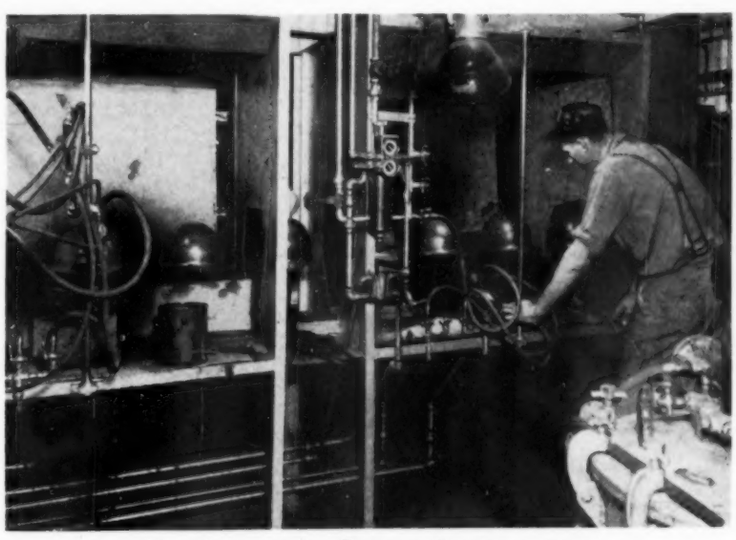
to follow was the adoption of a helmet already in production. Available for this purpose were the French and British helmets. The former, while lighter and more pleasing in appearance, was not as reliable ballistically. The British helmet, which had much greater impact resistance, was therefore standardized as Helmet, M1917. Following its adoption by the American Army, facilities for the manufacture of the British-type helmet were set up in this country. This method of taking over a helmet already in use by an ally, while giving maximum production in the shortest time, left the Army without a head covering that could be considered distinctly American. This consideration along with certain shortcomings of the helmet, such as insufficient coverage and poor balance, led to the initiation, shortly after the war, of a project for the development of an improved helmet.



WELDING CHIN-STRAP CLIPS ON THE NEW HELMET

Within the scope of this project there were considered not only the standard models of the principal armies in Europe but also many experimental models developed in this country. All were studied on the basis of weight, ballistic resistance, and coverage—the three fundamental characteristics of helmet design. In addition, serious attention was given to related problems such as ease of manufacture, type of finish, method of suspension, balance, appearance, and interference with other equipment.

As a result of this investigation, one helmet was selected for further study and comparison with the M1917. This was an experimental helmet designated as the 5A. The 5A was a deep, pot-type helmet giving added protection for the sides of the head. After many preliminary trials, extended-service tests of the 5A and M1917 helmets were conducted at Fort Benning in 1926. These tests showed that the 5A helmet was more easily penetrated and battered out of shape than the M1917. In addition, the M1917 was lighter and interfered less when firing the rifle. For these reasons, the Infantry Board recommended continuation of the M1917 as the standard helmet. Further comparative tests in which special attention was paid to the composition of the helmet steels were conducted at Aberdeen Proving Ground. Again the 1917-type helmets proved to be superior, and, as a result of these tests along with those of the Infantry Board, it was decided in 1932 by the authorities concerned to cease testing pot-shaped type helmets.



THE HELMETS ARE PAINTED AUTOMATICALLY

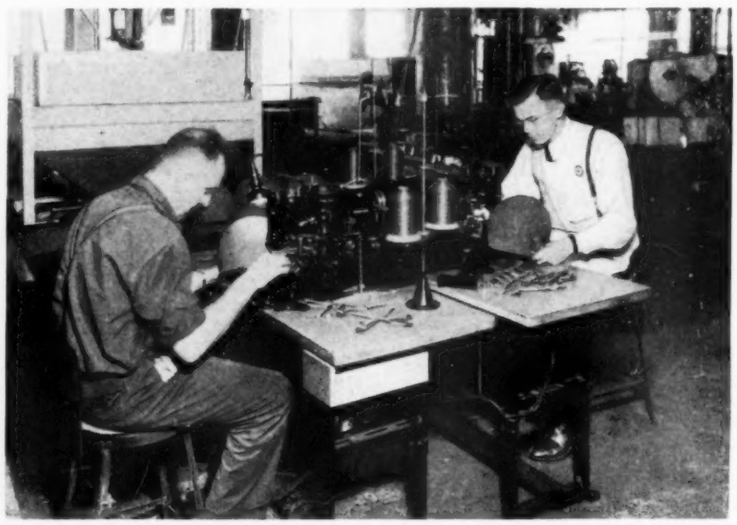
When it became evident, late in 1940, that the United States was to have an army second to none in the matter of equipment, the problem of a new type of helmet was again resurrected. In the light of events in Europe, it was apparent that a washbasin-type helmet, originally designed to protect soldiers in trenches from fragments of shells bursting overhead, would not be adequate in a war of movement where missiles could come from all directions—even from below, as in the case of parachute troops.

THE problem of developing a satisfactory shape for a helmet was given to the Infantry Board. The first step was to determine the essential characteristics of a helmet. The Infantry Board stated in its report: "Research indicates that the ideal shaped helmet is one with a dome-shaped top and generally following the contour of the head, allowing sufficient uniform headspace for indentations, extending down in the front to cover the forehead without impairing necessary vision, extending down on the sides as far as possible without interfering with the use of the rifle or other weapons, extending down the back of the head as far as possible without permitting the back of the neck to push the helmet forward on the head when the wearer assumes the prone position, to have the frontal plate flanged forward to form a cap-style visor, and to have the sides and rear slightly flanged outward to cause rain to clear the collar opening."

The problem of securing a satisfactory suspension was attacked concurrently with the development of the helmet rather than as an afterthought as was previously the case. The M1917 helmet was taken as the most suitable for protecting the top of the head. By trimming off the brim and

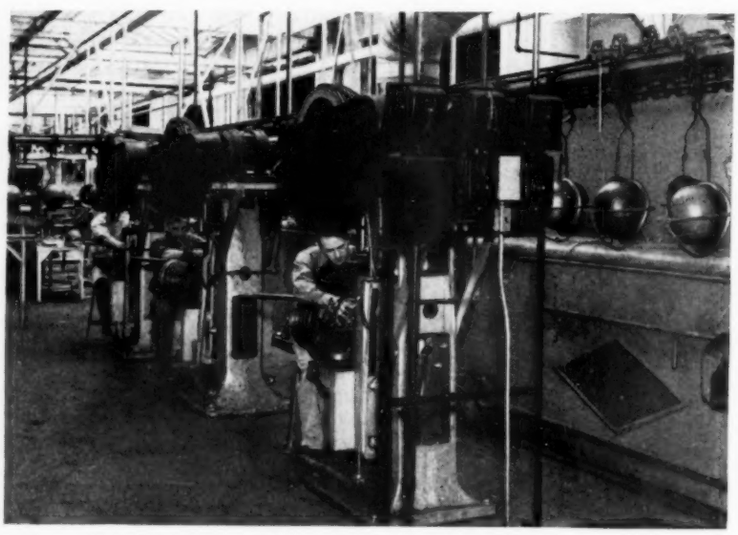
welding to the remaining dome-shaped piece a visor and skirt-like extensions to protect the sides and rear of the skull, a pot-type helmet was secured which was then fitted over what may be considered a modified football helmet. The helmet thus obtained was then adjusted to give greater vertical vision and to allow more room on the sides for indentations caused by missiles.

It was soon discovered that the football-helmet type of suspension was superior to all other methods of holding the helmet on the head. Accordingly, a fiber liner, fitting snugly to the inside of the helmet, was constructed using this type of suspension. When covered with olive-drab cloth, this liner presented a surprisingly neat appearance—not unlike a tropical helmet. The completed liner and the method of fitting the helmet, which was designated as the TS-3, is shown on page 932.



Riveting Chin Straps to the Helmet

The reaction to the TS-3 helmet was entirely favorable. By bringing the sides of both the helmet and liner well down over the head, not only was greater protection for the skull assured, but, in addition, the center of gravity of the combination helmet and liner was brought closer to the center of gravity of the head, thereby allowing helmet and head to move as a unit, eliminating much of the rocking that was such an unpleasant feature of the M1917 helmet. Additional tests showed that the TS-3 helmet did not interfere with firing the rifle from any position, did not obscure the field of vision too greatly, and was more comfortable to wear.



Beading the Helmet Edge with Strip Steel

Since the promise shown by the TS-3 helmet was judged sufficient to warrant further development, the McCord Radiator Company was requested to make up a number for extended-service and ballistic tests. For this purpose, presses capable of stamping out helmets in a single draw were used. The Hadfield manganese steel used in the M1917 helmet was chosen for the new helmets as well. While the specifications for the M1917 helmet required it to resist penetration by a 230-grain, caliber .45 bullet with a velocity of 600 feet per second, the performances of these helmets indicated that the actual ballistic limit was much higher. Therefore, the requirement set up for the TS-3 helmet called for resistance to penetration by a similar bullet with a velocity of 800 feet per second. In other words, the new helmet should not be penetrated by a bullet from the service pistol fired at point-blank range.

Service tests on the production model of the new helmet confirmed earlier opinions as to the excellence of the TS-3 design; it was all that could be expected—and more. As for the ballistic qualities, one can do no better than quote the conclusion contained in the report submitted by Aberdeen Proving Ground: "The experimental helmet, TS-3, is ballistically superior to the requirements for a military helmet."

This really ends the story of the search for a helmet as nearly perfect as possible. Official action followed soon afterward, and on June 9, 1941, the standardization of the TS-3 as the "Helmet, Steel, M1," was approved. Production of the M1 helmet is now mounting rapidly—soon it will be a familiar sight around Army camps, and before long every American soldier will be equipped with the finest helmet that science and engineering skill can produce.

Editor's Note.—Although the helmet is one of the most ancient and most widely used types of protective armor, the suits of armor worn by the knights and princes of the fifteenth and sixteenth centuries are of especial interest to students of the metallurgical arts. Stephen V. Grancsay, Curator of Armor at the Metropolitan Museum of Art, New York City, in 1935 prepared and issued a beautiful brochure containing twenty-one halftone plates of classical arms and armor used by historic personages which should be of value to those interested in the craft. The illustrations begin with the etched and gilded harness of Galiot de Genouilhac (1465-1546), and conclude with the partisan of the state guard of Maurice of Nassau, Prince of Orange (1567-1625), and the fauchard of the state guard of Cardinal Camillo Borghese.

Officer Training

Selective Processing in the Mass Production of Ordnance Leaders

Col. George W. Outland*

"WE NEED officers, thousands of officers, Ordnance officers with technical training, with military training, with modern ideas, physically fit and able to assist in managing the vast enterprise upon which the Ordnance Department has embarked." This urgent appeal now comes by mail, by telephone, and by wire from both field and industrial establishments. What is being done to solve this problem? Ordnance officers want to know; industrialists want to know. This article will attempt to explain.

America's industrial giants are now reaching their stride. Guns, tanks, and ammunition are rolling off the production lines in ever-increasing numbers. These "grapes of wrath" spewn from this arsenal of democracy will soon check the enthusiasm of our enemies if we can keep these weapons belching destruction amongst their ranks. But to build is not enough; a gaily bedecked tank parading the streets of Detroit will win no battles. Tanks must fight in deadly combat to win, and they must be kept fighting. As these weapons become combat casualties, thousands of Ordnance officers, leading and directing many more thousands of trained soldier mechanics, will be needed to place them back on the firing line. The reputation of the industrialist and the professional soldier alike depends, not only on the perfection of our product as it leaves the production line, but also on its striking force in combat. And the maintenance of this striking force depends on our Ordnance officers and enlisted men in the field.

OFFICER CANDIDATES AT ABERDEEN

Where will these thousands of Ordnance officers come from? Will our supply ever meet our demands? Will our demands continually increase as combat experience emphasizes the necessity for more and more competent personnel to build and maintain these complex machines of war? Is there the possibility that the plains of Libya will be strewn with countless thousands of our weapons, inoperative due to combat casualties and irreparable because of a shortage of competent Ordnance maintenance personnel?

The President's call for "forty thousand tanks" no doubt caused interesting reactions among various classes of people; to some it heralded high wages and long hours of work; to others, perhaps, industrial expansion and fat contracts; to the average citizen, higher taxes, no doubt, but crushing defeat to the enemy. Normal reactions, yes; and it is also normal for an ex-cavalryman, who in a previous war used a horse as a means of transportation, to think in terms of countless stable calls—that unromantic task of keeping each mount in fit condition to fight. Mechanical mounts need grooming too—not the brush-and-comb type of the horse era but rather the grooming that complicated mechanisms need from the hands of competent mechanics, men who know them like a doctor knows the anatomy and who are trained to rebuild them in the combat zone. Here, a relatively few returned to battle at a critical time may mean the difference between victory and defeat, and the value of these few in terms of national safety may be worth thousands on order, in production, or in transit.

Since the founding of ARMY ORDNANCE in 1920, its readers have been familiar with the operations of the Ordnance Department. They have knowledge of the diversified tasks to which Ordnance officers may be assigned and the years of training normally given to their educational development. It is today obvious to them that the number trained during peace time has been so small, compared with those needed for an army of from four to ten million men, that it is insignificant.

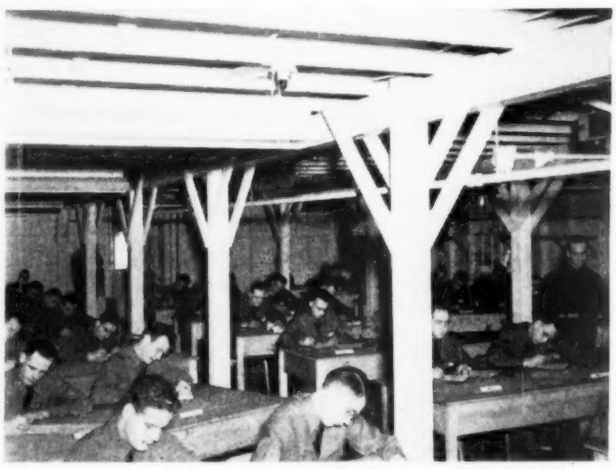
The small peace-time group of Regular officers, which numbered about 350, already has been augmented by about 10 times that number of Reserve officers called from civilian life; and yet we have hardly begun to fight. While our industrial effort already has progressed to the point where the product of our toil is beginning to affect the results of battle in many foreign lands, the expansion of our own fighting forces has only begun. We shall need thousands of trained Ordnance officers for the field forces, and our remaining reservoir of reserves is limited. We are, therefore, preparing for mass production of officers. By the time this article is published, our "tooling-up" period will be nearing completion. Officer-candidate courses have been in operation, with limited enrollment, for several months. Our "production-line" training technique is being perfected. The products of this training program are already supplying some of our more urgent needs.

THE old training technique, applicable to peace-time necessities, was quickly discarded during the early phases of our emergency training. Specialization has become the rule rather than the exception. Reserve officers, graduates of our civilian schools, are given short courses of intensified training in ordnance specialties. A large percentage of the Ordnance Reserve officers assigned to field forces already have graduated from one or more of these courses.

*Commandant, the Ordnance School, Ordnance Training Center, Aberdeen Proving Ground, Md. Colonel, Ordnance Department, U. S. Army.

OUR need to produce Ordnance officers from men with very little previous training presents a different problem. While the Reserve officer usually possessed some foundation or background in ordnance training, with some military experience to build upon, the officer candidate is not so fortunate. Here we must take enlisted men, too often with only a few months' military service, and complete their military as well as specialized training within a short time. Another problem connected with such training is the necessity for careful weeding out of those candidates who fail to meet the minimum standards. The officer who satisfactorily completes the course must possess not only the necessary professional knowledge but also must be a leader capable of using such knowledge effectively, whether he be assigned to a laboratory, a manufacturing plant, an Ordnance depot, or a maintenance company operating in the combat zone.

Unless one considers the diversified tasks to which Ordnance officers may be assigned in time of war, the problems involved in their proper selection and assignment never can be brought into accurate focus. If we ask a dozen of the "old guard" for their ideas regarding the basic qualifications of an Ordnance officer, careful analysis will disclose that each answer is usually filled with the prejudice resulting from his own limited personal experience. The research specialist will specify a man with a scientific background. The manufacturer will not be satisfied with a man who does not have an engineering degree. Design sections will want men trained primarily in their specialties. Administrative officers will want men who have had business training. The man in the field, while he may feel that he gets the left-overs, will want officers who can handle enlisted men, regardless of their formal educational advantages.



STUDENT OFFICER EXAMINATION

All too frequently these specifications omit the one general characteristic which every man who wears the uniform should possess—that is, he should have the qualifications of a soldier. Dressing a civilian in a uniform, placing ornaments on his shoulders, and even issuing medals, swagger sticks, or saber chains, does not make him a soldier. Have we forgotten the lessons of the last war—our difficulties in whittling the corners off square pegs? Let me assure my readers that our officer-candidate course is producing officers who are soldiers first of all. They walk like soldiers, they look like soldiers, they salute properly, they dress the part, they have learned discipline, they are proud and unafraid to face the rigors of the conflict ahead—they are men. Assign them where you will, work them hard, give them opportunity and proper leadership, and they will remain loyal, confident, fearless.

These men, ranging from the sons of immigrants to the son of our Vice-President, come from practically every walk of life, from the homes across the tracks and from Fifth Avenue. Men who have had no formal education beyond high school sit side by side with Rhodes scholars in the same classrooms, study the same subjects, and eat the same kind of bread. Look their pictures over and see if you can distinguish between them. Come to the school, inspect their long scheduled hours of training, and analyze their grades; you will be pleasantly surprised at what you find. The first student to fail in the officer-candidate course at this school was a graduate of one of our large universities. Running neck and neck for first place at that time were a university graduate and a man whose education beyond high school was largely in the field of experience. Don't misunderstand this as indicating that a low order of intelligence can be tolerated. Candidates with an I.Q. rating below 110 are not accepted for training. In fact, those below 120 usually have difficulty in passing the strict requirements of the course.

THERE are three basic qualifications without which no candidate may expect to graduate. First is a physically fit body; secondly, a highly intelligent mind, and thirdly, the self-confidence and courage necessary for leadership. Unless a man has a strong body, he will be unable to withstand the rigors of the course. Six days a week for thirteen weeks, his life is controlled from 6 o'clock in the morning until the end of his study period at 9 o'clock in the evening. A slight illness may be enough to place him hopelessly in arrears with the scheduled work.

A high order of intelligence is necessary because of the varied nature of the subjects taught. Army paperwork, that bugaboo of red tape so often profaned and yet so necessary, must be mastered. Then come the purely ordnance specialties, such as ammunition and its supply, small arms and aircraft armament, artillery, automotive mechanisms, fire-control instruments, and the problems of supply and shop management. A broad field, yes—too broad for any one to master in a lifetime, let alone in a few short weeks. As though they were sitting in a theater and seeing a fast-moving drama unfold before their eyes, they are exposed to ordnance knowledge. Their agile minds catalog, index, and carry away the framework only. Reconstruction and enlargement upon the theme must come when necessity demands, at future times and perhaps in distant lands.

Officers in the military service, like supervisors in industry, must also possess that intangible spark called leadership if they are to be successful in handling men. This attribute, so difficult to define adequately, is sometimes just as difficult to uncover and develop. Our officers must demonstrate such qualities before graduation. It is an important part of the school's responsibility to search out and cultivate these necessary qualifications when they lie dormant within the candidate. Even more important, it is our duty to deny the rank of officer to those within whom we cannot hope to develop that fine sense of leadership so necessary for men regimented together and fighting under the hot impulses of battle.

The question naturally arises as to whether we may ex-

pect uniform and satisfactory results from such a diversified collection of candidates. One sometimes hears the remark that Ordnance officers must first of all be engineers. Prominent Ordnance officers have sometimes emphasized in the past that officers' training should be largely technical. However, the responsible tasks to which these officers may be assigned during this emergency are so varied that no set formulae can be considered wholly satisfactory. Officers graduating from this course may need further specialized training to equip them fully for their jobs. The Ordnance School conducts 9 different courses for specializing officers, with a capacity for 230 student officers in these courses.

The officer instructors in the school are practically all temporary officers; their backgrounds are as diversified as are those of the students in the officer-candidate courses. Graduates in literature and law have, in some instances, been more successful than engineers. This, of course, does not indicate that men of other professions are as adaptable to ordnance training as engineers, but rather that basic intelligence, coupled with proper initiative, is of greater importance.

DRILL IS AN ELEMENT OF DISCIPLINE

THE development of training facilities for enlisted men, officers, and officer candidates in such large numbers has necessitated a large expansion of the Ordnance School. This expansion was discussed in a previous article in this magazine by Brig. Gen. J. S. Hatcher, the commanding officer of the Ordnance Training Center at Aberdeen Proving Ground, of which the Ordnance School forms a part. (See ARMY ORDNANCE, January-February 1942, Vol. XXII, No. 130, p. 565.) Brig. Gen. B. W. Simpson commands the Ordnance Replacement Training Center, which constitutes the other important part. Since General Hatcher's article appeared, a further expansion of the Ordnance School has been authorized which should be completed by early summer. Those visitors to Aberdeen Proving Ground who have made periodic journeys to this center of ordnance interest since its establishment during the World War but who have not seen the post during the past year and a half, will be surprised to find at "Camp Rodman," just outside the old proving-ground gate, a camp housing, feeding, and training some 16,000 Ordnance personnel.

The stress of emergency also has necessitated the modification of all courses for both officers and enlisted men. Students progress from one classroom to another, specialized equipment being installed in each, and training is given by methods similar in principle to the production line. The school is more of a training factory than a university. The most modern training-aid methods are employed to speed up and clarify the subject matter; films, film strips, charts, and diagrams are used, as well as complete items and their components. Students in overalls with tools in hand are the rule rather than the exception. We are firm believers in actual experience, in so far as facilities and time will permit.

The selection of qualified students for the officer-candidate courses is becoming a serious problem as their number increases. All candidates are selected from enlisted personnel. Selection boards at various military centers pick the most promising applicants. It is of great importance that a high standard for these candidates be maintained. We know that readers of this magazine are interested in our problem, and we hope they will be able to direct to us competent personnel from among their acquaintances. Applications for these courses are made through military channels, and each month large numbers must be selected. Initiative on the part of each candidate is all that is necessary to make his wish for such training known. There is no secret door for entering the course. A proper application blank is readily available to every enlisted man who but has the initiative to request one.

While the student is in school, he is under constant surveillance by members of the instruction staff. Whether attending class, at mass athletics, or in the study rooms, his conduct is being observed. Grades are given in all courses. He must meet the minimum standards or be relieved from the course. Experience indicates that from twenty to twenty-five per cent become deficient. It is hoped that our selection process will be improved, so that this number will be reduced. The backward student not only consumes the time of the instructor and holds the other students back, but also takes the place of another man who might be more adaptable for such training.

IN CONCLUSION, let us consider briefly the evaluation of leadership as a necessary attribute in an Ordnance officer. We place this high on our list of requirements; it is considered so essential that candidates with excellent academic averages are sometimes relieved from the course because of leadership deficiencies. No other factor is given greater weight in the course. It may be that we are motivated by the belief that our responsibility extends beyond these men and the troops they are to command even to their future careers after the war is won and they return to their civilian pursuits. The students usually come to us during the early months of their Army careers and largely during the formative period of their existence. Anything which can be done now to stimulate and develop those attributes which are necessary for a successful leader of men will pay dividends during the remainder of their lives.

Some authorities assert that leaders are born, not made. We cannot entirely agree with this premise. True, we frequently come in contact with some one who seems to possess a magnetic spark which draws men to his shadow and enables him to impose his will effortlessly on others. While nature may have favored him with a pleasing personality, a soothing voice, or a fine physique, the spark which ignites the flame of men's respect for him is largely self-engendered and self-preserved. Among children, we frequently find groups following the advice and leadership of an urchin from the back streets. It is our belief that such a child is no

more a born leader than the others but rather that his environment has necessitated an earlier development of his self-reliance. Because of lack of parental care, he may have obtained a greater knowledge of some so-called worldly things from which the other youngsters have been shielded by their home environment. The group is thus drawn to him by admiration for his greater knowledge and for the self-reliance he has acquired. Such a leader can arouse, control, mold, and direct the minds of his followers and can utilize them to attain a desired end. We hope to develop a high type of self-reliant leadership in every officer who graduates from the candidate course.

When the candidate reports for duty at the school, he has, of course, passed beyond the ragamuffin stage when boys sometimes play hooky to visit the "old swimming hole." On the other hand, the sheltered environment provided by doting parents may still be suspended like a cloud over his personality; the boy who worked his way through college may be far more self-reliant and independent. It is a part of our job to lift off this lid and let the man within emerge as a personality.

Inspection Promotes Efficiency

In many ways the school operates as a "melting pot." While the course is not competitive in the normal sense of the word, each student realizes that he is in definite competition with a standard of proficiency which has so many variable factors that it defies complete definition. He knows that he may be relieved by the commandant and returned to his organization without hesitation and for any reason which may be considered justifiable.

Within the "melting pot," surging one against another, is a wide variety of personalities. All-American halfbacks, accustomed to growling at the guards for not opening up the opposing line, timid souls accustomed to the bark of the boss on Blue Mondays, wisecrackers who dish it out far better than they can take it, "yes-men" who have found it easier to agree than to expound their own ideas, strong-willed men with an occasional one too much in love with the sound of his own voice—they are all here, taking it, and, in the main, liking it. It is a source of much gratification to the school staff to see these men adjusting themselves to new viewpoints and new environments, accepting assignments after graduation without hesitation, and taking on added courage and resourcefulness as their responsibilities grow.

LET us examine briefly some of the human characteristics upon which every candidate is graded. While marks in these subjects indicate the student's ability, they also serve to detect weaknesses for the benefit of his instructors. It is surprising how frequently improvements can be obtained by proper guidance.

Heading the list is "physical fitness." We believe that there is no place in our modern combat forces for leaders who are not physically and mentally young. The student is required to participate in mass athletics in addition to drill. Here we observe his physical stamina and his ability to work as a member of a team. "Military bearing and personal appearance" are the subject of constant attention throughout the course. To be a leader among men, one must look the part. The candidates must appear neat and tidy and must possess a dignity of demeanor that commands respect from seniors and subordinates alike.

The candidate's "attention to duty" is another subject that is carefully checked. It is not enough for him just to "get by" the course unless he is giving all he has to his efforts. Some men, possessing keen analytical minds, are more alert and can work more rapidly than others. We require them to give their best continually, in order to develop their full capacity. These men may become excellent staff officers if they do not develop lazy habits.

We measure a candidate's "leadership" by his ability to direct, control, and influence others, either at work or at play, on the drill field or on the basketball court. One interesting phase is the candidate's demeanor when facing his classmates from a platform during the delivery of a talk prepared by him. All too frequently, our military leaders have difficulty in effectively presenting their knowledge from a public platform.

"Force" is a quality which generally can be developed at drill. Think of some of the first sergeants you have known. They are not all the Sergeant Quirk type of which one reads in fiction, but they have attained their rank largely through the force of their own personalities. Strangely enough, some men cannot develop this characteristic. Like the draftsman pushing a pencil in the back room, who attains contentment within his own small sphere of influence, these are the men who by nature choose not to lead. They make poor officers.

The processing of 2,000 officer candidates through a school is no small task or light responsibility. This is the number who will be attending courses at the Ordnance School early this summer. The quality of our product depends, first, upon the quality of our students and, secondly, upon the quality of our instruction staff. The school facilities, when completed, will represent an investment of many millions of dollars. The 325 officers on the staff and faculty, as many as there were in the entire Ordnance Department a few years ago, will have had, for the most part, from 6 months' to 2 years' experience.

The Ordnance School has a further responsibility in training about 230 officers and 1,600 enlisted men at Aberdeen, and in directing the training of about 700 students at its branch schools. When one considers this load, in addition to the Replacement Training Center activities, the Bomb Disposal School, and the Base Shops School which are in operation at Camp Rodman, one begins to recognize the vastness of the training program which is now under way at the Ordnance Training Center at Aberdeen Proving Ground.

Army Reorganization

The Military Establishment is Streamlined for Victory

THE President has approved a reorganization of the War Department and the Army, effective March 9, 1942, and to remain in effect until six months after the termination of the present war. Both are now organized so as to provide under the Secretary of War and the Chief of Staff a War Department General Staff, a Ground Force, an Air Force, and a Services of Supply Command, all with headquarters in Washington, D. C., and, in addition, such number of overseas departments, task forces, base commands, defense commands, commands in theaters of operations, and other commands as may be necessary to the national security. Charts on pages 941 to 944, inclusive, illustrate the organization of the War Department, the Army Ground Forces, the Army Air Forces, and the Services of Supply. It is anticipated that the experience of the first three months under the new organization will indicate the desirability of minor modifications within the principal subdivisions.

The functions, duties, and powers of the chiefs of the following arms have been transferred to the jurisdiction of the Commanding General, Army Ground Forces: Infantry, Cavalry, Field Artillery, and Coast Artillery Corps (except those relating to procurement, storage, and issue). The functions, duties, and powers of the Commanding General, GHQ Air Force (Air Force Combat Command) and the Chief of the Air Corps have been transferred to the jurisdiction of the Commanding General, Army Air Forces. The functions, duties, and powers of the Chief of Coast Artillery relating to procurement, storage, and issue have been transferred to the jurisdiction of the Commanding General, Services of Supply.

Supply arms and services and War Department offices and agencies now under the direct command of the Commanding General, Services of Supply are: (1) those parts of the Office of the Under Secretary of War engaged in functions of procurement and industrial mobilization, (2) the Budget Advisory Committee, (3) the Surgeon General, (4) the Chief of Engineers (except with respect to civil functions, for which he will report directly to the Secretary of War), (5) the Chief Signal Officer, (6) the Quartermaster General, (7) the Chief of Ordnance, (8) the Chief of Chemical Warfare Service, (9) present supply functions of the Chief of Coast Artillery and the military and civilian personnel assigned thereto, (10) the Chief of Finance, (11) the Judge Advocate General (except with respect to courts-martial and certain legal matters for which he will report directly to the Secretary of War), (12) The Adjutant General, (13) the Provost Marshal General, (14) the Chief of Special Services, (15) the Chief of Chaplains, (16) all corps-area commanders, (17) all general depots, (18) ports of embarkation, staging areas, and regulating and reconsignment stations for overseas shipments.

WAR DEPARTMENT GENERAL STAFF (chart on page 941).—The Chief of Staff is the immediate adviser of the Secretary of War on all matters relating to the military establishment and is charged by the Secretary of War with the planning and execution of the military program.

The War Department General Staff under the direction of the Chief of Staff coördinates the development of the armed forces of the United States and insures the existence of a well-balanced and efficient military team. The War Department General Staff assists the Chief of Staff in the direction of the field operations of the Army of the United States. It is specifically charged with the duty of providing such broad basic plans as will enable the Commanding Generals of the Army Ground Forces, Army Air Forces, Services of Supply, defense commands, task forces, and theaters of operations to prepare and execute detailed programs.

The War Department General Staff includes the following divisions, each division being under the immediate control of an Assistant Chief of Staff: (1) Personnel Division (G1) which is charged, in general, with those duties of the War Department General Staff relating to the personnel of the Army as individuals; (2) Military Intelligence Division (G2) which is charged, in general, with those duties of the War Department General Staff relating to the collection, evaluation, and dissemination of military information; (3) Organization and Training Division (G3) which is charged, in general, with those duties of the War Department General Staff relating to the mobilization, training, and organization of the military forces; (4) Supply Division (G4) which is charged, in general, with those duties of the War Department General Staff which relate to the supply of the Army; (5) Operations (formerly War Plans) Division which is charged, in general, with those duties of the War Department General Staff relating to the formulation of plans and the strategic direction of the military forces in the theater of war; (6) Secretariat, War Department General Staff, which is charged with the administration of the Office of the Chief of Staff and will maintain a message center for the Chief of Staff and the War Department General Staff.

Other War Department agencies.—The Legislative and Liaison Division is charged with supervising the preparation of legislation requested by the War Department, with preparing reports to committees of Congress, and with the maintenance of liaison necessary thereto. The Military Intelligence Service, under the direction of the Assistant Chief of Staff, Military Intelligence Division, War Department General Staff, operates and administers the service of the collection, compilation, and dissemination of military intelligence. Under policies prescribed by the Secretary of War and the Chief of Staff, the War Department Bureau of Public Relations is the agency for the dissemination of military information to the public from the War Department, for the establishment of public-relations policies and practices, and for liaison with other Government agencies on matters of mutual interest in the field of public relations.

ARMY GROUND FORCES (chart on page 942).—Under policies prescribed by the Chief of Staff, the Commanding General, Army Ground Forces, is charged in general with the functions, responsibilities, and authorities of command authorized by law, Army Regulations, and custom over indi-

viduals and units assigned to the Army Ground Forces. The mission of the Army Ground Forces is to provide ground-force units properly organized, trained, and equipped for combat operations.

The following duties are among those specifically assigned to the Army Ground Forces: (a) The operation of Infantry, Field Artillery, Coast Artillery, and Cavalry replacement training centers and schools for the Army Ground Forces, including officer-candidate schools for the Army Ground Forces; (b) The organization of tactical units as directed by the War Department; (c) The training of all tactical units assigned to the Army Ground Forces; (d) The organization, equipment, and training of such task forces as are directed by the Chief of Staff; (e) The development of tactical and training doctrine, tables of organization, tables of basic allowances, military characteristics of weapons and equipment, and operational changes needed in equipment for the Infantry, Field Artillery, Coast Artillery, Cavalry, and specialized combat units. Under the chief of the Requirements Division, a separate section has been established for each of the above combat arms of the Army Ground Forces; (f) The review with the Commanding General, Services of Supply, of the tactical doctrine, military characteristics of weapons and equipment, tables of organization, and tables of basic allowances of Services of Supply units assigned to the Army Ground Forces; (g) The discharge of personnel functions formerly performed in the offices of the Chiefs of Infantry, Field Artillery, Coast Artillery, and Cavalry, less those now engaged in the procurement of officer candidates; (h) The supply of Infantry, Field Artillery, Coast Artillery, and Cavalry personnel to the Army Air Forces, Services of Supply, defense commands, theaters of operation, and overseas forces in accordance with policies announced by the Chief of Staff; (i) The development jointly with the Commanding General, Army Air Forces, of ground-air support, tactical training, and doctrine in conformity with policies prescribed by the Chief of Staff.

ARMY AIR FORCES (chart on page 943).—Under policies prescribed by the Chief of Staff, the Commanding General, Army Air Forces, is charged, in general, with the functions, responsibilities, and authorities of command authorized by law, Army Regulations, and custom over individuals and units assigned to the Army Air Forces. The mission of the Army Air Forces is to procure and maintain equipment peculiar to the Army Air Forces, and to provide air-force units properly organized, trained, and equipped for combat operations. Procurement and related functions will be executed under the direction of the Under Secretary of War.

The following duties are among those specifically assigned to the Army Air Forces: (a) The operation of Army Air Forces replacement training centers and schools, including officer-candidate schools, for the training of personnel in pilot functions and specialist nonpilot functions of combat and ground crews and in all duties involving the care, supply, and maintenance of aëronautical matériel; (b) The organization of air-force tactical units as directed by the War Department; (c) The training of all tactical units assigned to the Army Air Forces; (d) The organization, equipment, and training of such task forces as are directed by the Chief of Staff; (e) The development of tactical and training doctrine, tables of organization, tables of basic allowances, military characteristics of aircraft, weapons, and equipment, and operational changes needed in equipment, aircraft, and weapons peculiar to the Army Air Forces; (f) The development jointly with the Commanding General, Army Ground Forces, of ground-air support, tactical training, and doctrine in conformity with policies prescribed by the Chief of Staff; (g) The supervision of all air-force activities in connection with the research, development, procurement, storage, supply, maintenance, and final disposition of military aircraft, accessories, supplies, facilities, and appurtenances used in connection therewith, including technical inspection and the issuance of pertinent technical instructions.

SERVICES OF SUPPLY (chart on page 944).—The duties and responsibilities placed on the Secretary of War by Section 5a of the National Defense Act, as amended, continue to be performed by the Under Secretary of War. The Director of Production continues to perform his present services, reporting directly to the Under Secretary of War.

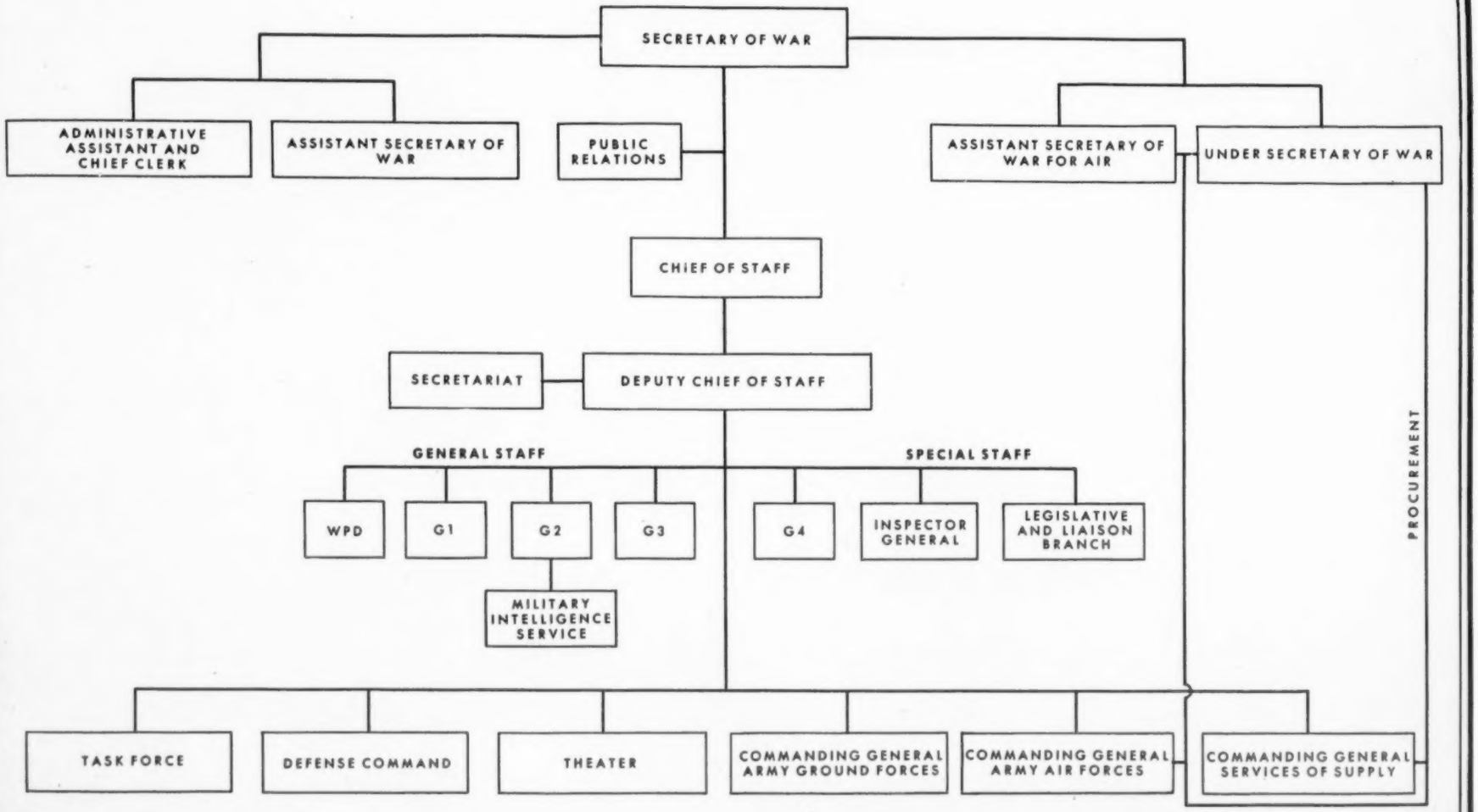
The Commanding General, Services of Supply, on procurement and related matters, acts under the direction of the Under Secretary of War and, on military matters, reports to the Chief of Staff. The Commanding General, Services of Supply, is charged in general with the functions, responsibilities, and authorities of command authorized by law, Army Regulations, and custom over individuals and units assigned to the Services of Supply.

The mission of the Services of Supply is to provide services and supplies to meet military requirements except those peculiar to the Army Air Forces. Procurement and related functions will be executed under the direction of the Under Secretary of War.

The Services of Supply consolidates under the jurisdiction of the Commanding General, Services of Supply, the supply arms and services, certain administrative services of the War Department, certain parts of the Office of the Under Secretary of War, certain boards and committees, general depots, ports of embarkation and auxiliaries, and corps areas.

The following duties are among those specifically assigned to the Services of Supply: (a) The direction and supervision of engineering research, development, procurement, storage, and distribution of supplies and equipment, except those peculiar to the Army Air Forces; (b) The establishment of purchasing and contractual policies and procedure; (c) Transportation and traffic control; (d) Construction for the Army; (e) The securing of War Department funds, the arrangement for their defense and justification before the Bureau of the Budget and Congress, and the control of fiscal policy; (f) The administration of all functions which are Army-wide in scope and which pertain to personnel as individuals, both military and civilian, to include premilitary training, mobilization of industrial man power, and labor relations; (g) The operation of replacement training centers and schools for the supply arms and services, including officer-candidate schools; (h) The operation of all reception centers; (i) The assignment of officers of the Services of Supply, including Army Air Forces and Army Ground Forces personnel on duty therewith; (j) The development of tactical and training doctrine, tables of organization, tables of basic allowances, military characteristics of weapons and equipment, and operational changes needed in equipment for the Services of Supply subject to the qualification listed above in paragraph (f) under the duties of the Army Ground Forces; (k) The command and control of all stations except those assigned Army Air Forces, defense commands, and theaters of operations.

ORGANIZATION OF THE ARMY



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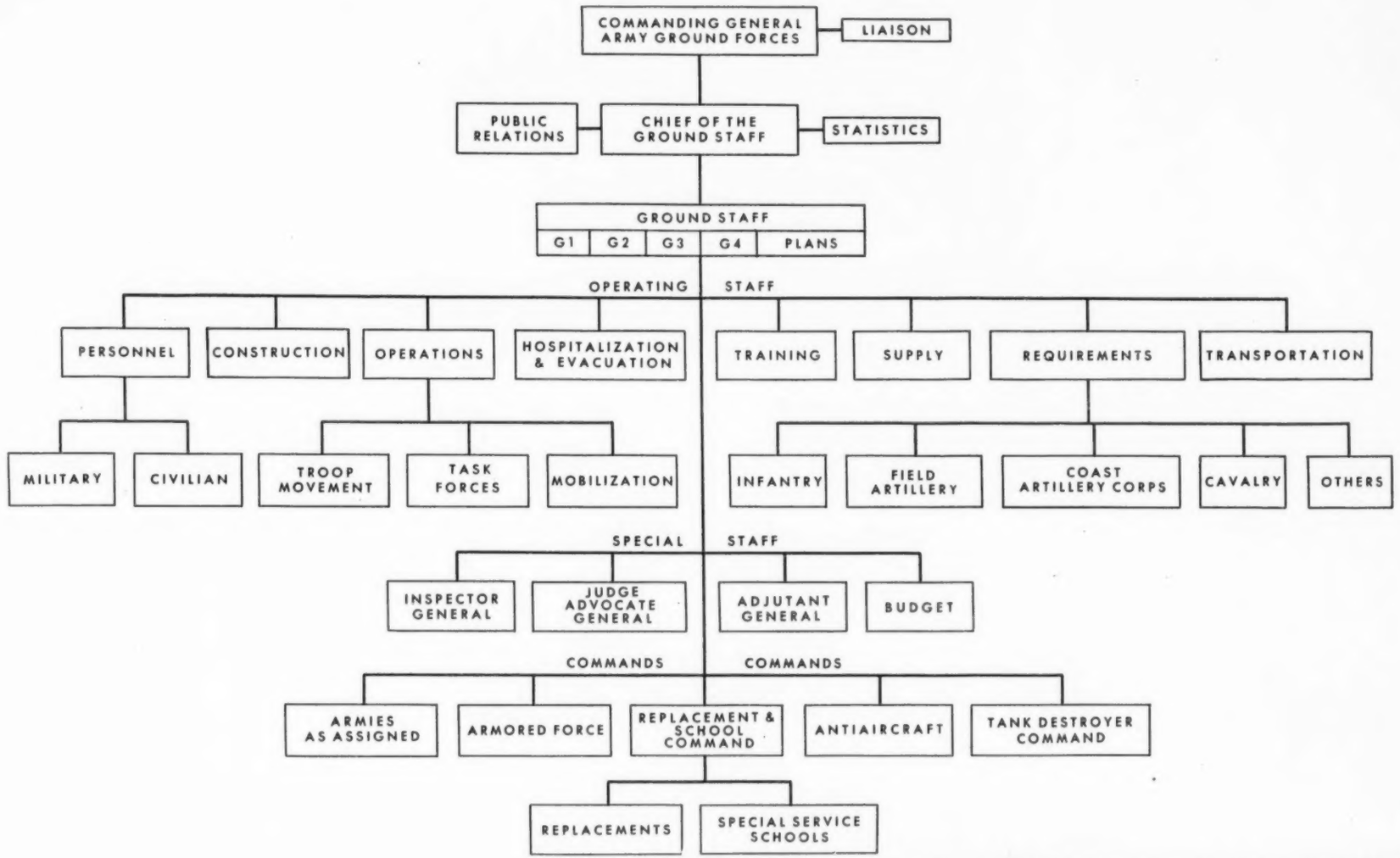
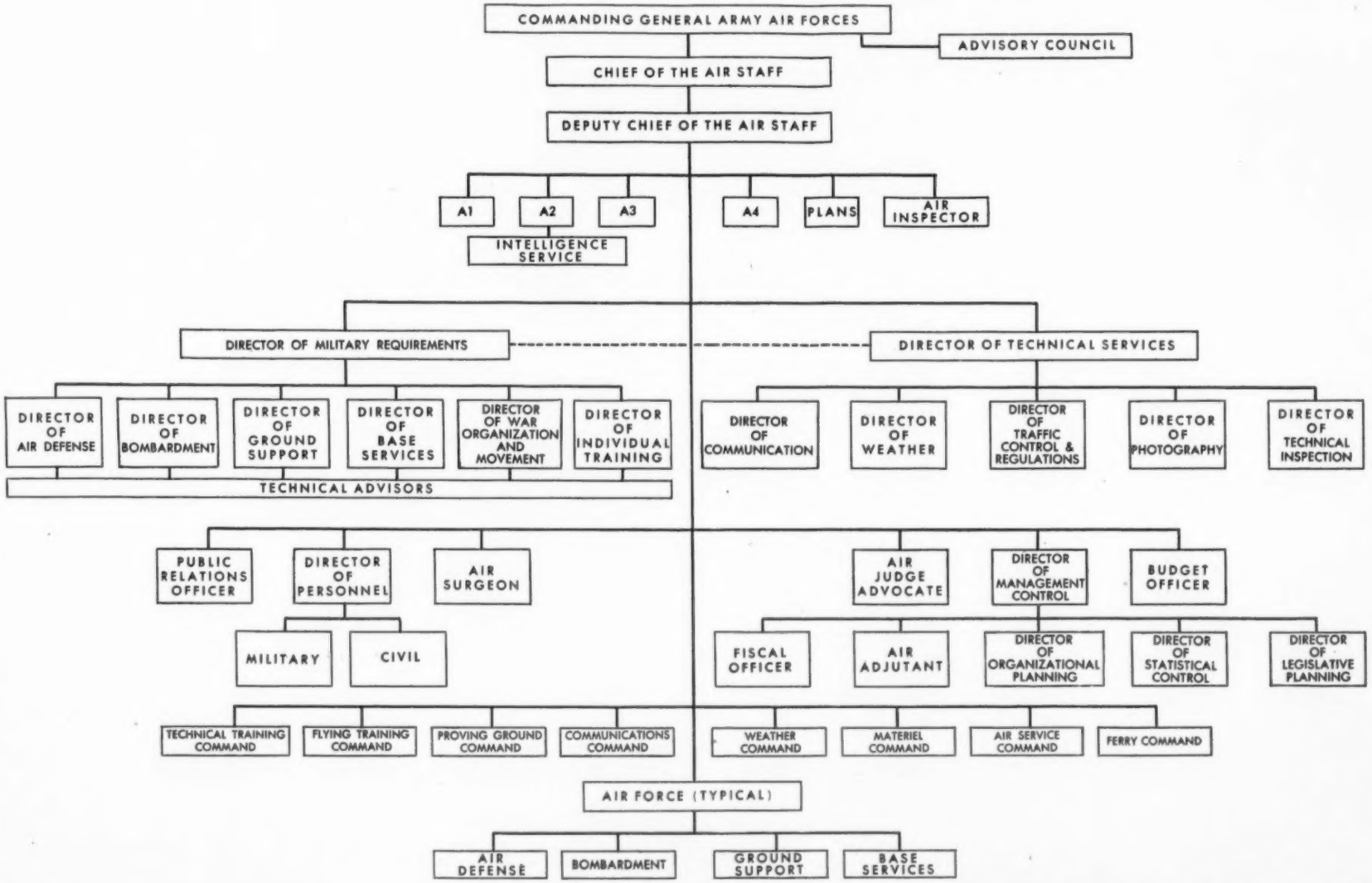
ORGANIZATION OF THE ARMY GROUND FORCES



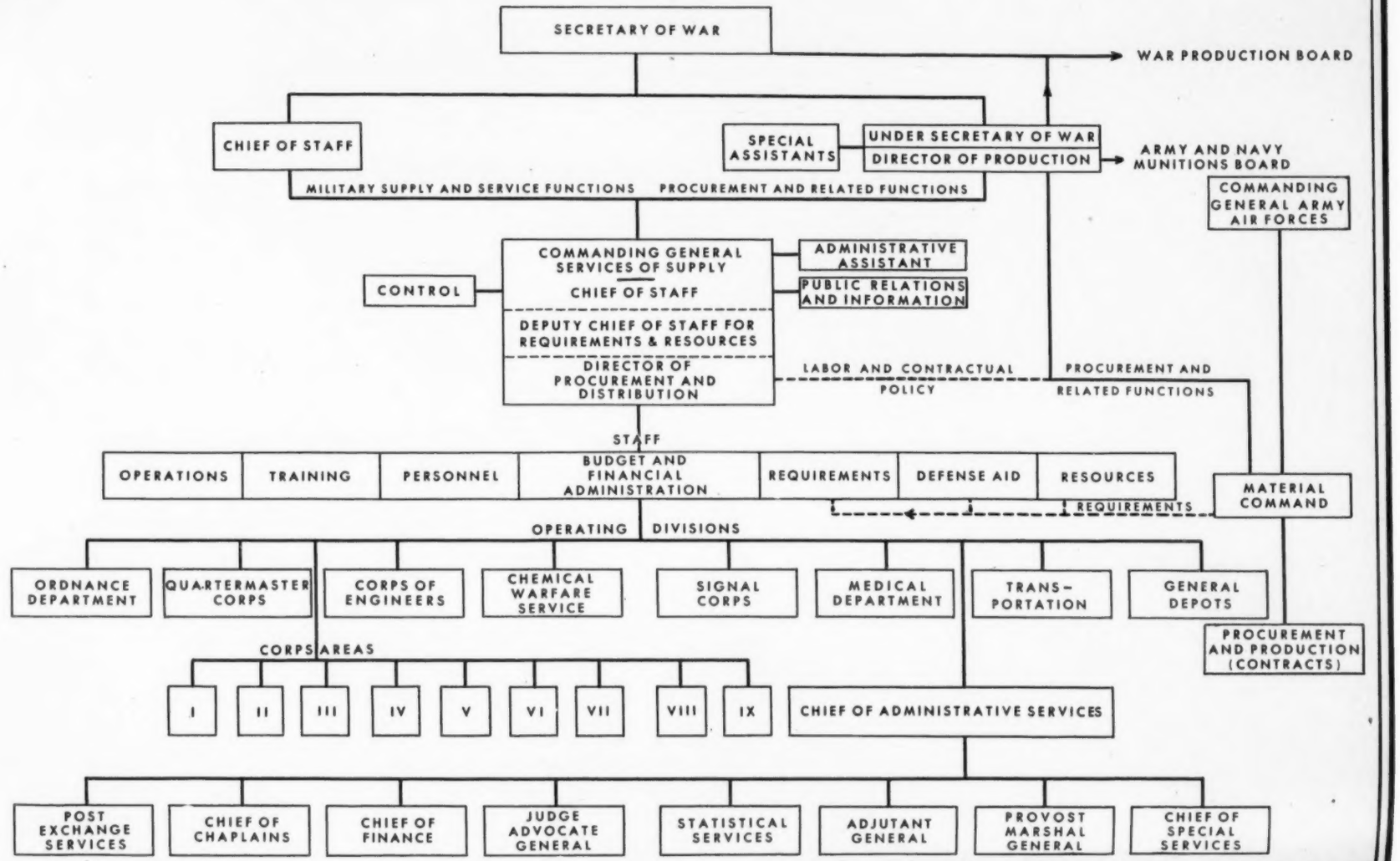
ARMY ORDNANCE, May-June, 1942 (Vol. XXII, No. 132)

ORGANIZATION OF THE ARMY AIR FORCES



ARMY ORDNANCE, May-June, 1942 (Vol. XXII, No. 132)

ORGANIZATION OF THE SERVICES OF SUPPLY



ARMY ORDNANCE, May-June, 1942 (Vol. XXII, No. 132)

Key to Arms Production

The Ordnance Procurement Districts at Work—Part I

Charles Hurd*

ALTHOUGH war production as yet has reached only a fraction of the goals set by President Roosevelt, the industrial regions of the Midwest have taken long steps toward conversion of peace-time industries into weapon factories. New plants are being erected and many existing facilities expanded in this region which is strategically safer than the exposed seaboards.

In this work, the thirteen Ordnance districts, established with skeleton forces in 1922, are rapidly becoming the organizers and reorganizers of American industry. Using the new pattern of war's demands, these offices are the operating branches of the General Staff at Washington which plot, direct, instruct contractors, set production schedules, and finally—under the newest regulations—actually finance war contracts by prepayment.

THIS is the first of a series of articles on the thirteen Ordnance procurement districts. The Ordnance district system, established in 1922 with skeleton forces, is today one of the most important factors in the armament-production program. This organization stems from the Office of the Chief of Ordnance in Washington but continues to function under the time-tried principle of decentralized operation under civilian leadership.

Following are the Ordnance Districts and the territory over which they have jurisdiction: (1) Boston District: Maine, New Hampshire, Vermont, Rhode Island, and part of Massachusetts; (2) Hartford District: Connecticut and part of Massachusetts; (3) New York District: lower New York and part of New Jersey; (4) Rochester District: the rest of New York; (5) Philadelphia District: eastern Pennsylvania, lower New Jersey, eastern Maryland, Delaware, Virginia, and the Carolinas; (6) Pittsburgh District: part of Pennsylvania and Maryland, and West Virginia; (7) Cleveland District: northern Ohio and northwestern Pennsylvania; (8) Cincinnati District: southern Ohio and Indiana, Kentucky, and Tennessee; (9) Birmingham District: Alabama, Mississippi, Louisiana, Georgia, and Florida; (10) Detroit District: all of lower Michigan; (11) Chicago District: northern Indiana, Illinois, and Michigan, Wisconsin, Iowa, Minnesota, and the Dakotas; (12) St. Louis District: Missouri, southern Illinois, Arkansas, Oklahoma, Kansas, Nebraska, Colorado, New Mexico, and Texas; (13) San Francisco District: California, Oregon, Washington, Idaho, Montana, Wyoming, Utah, Nevada, and Arizona. The Los Angeles Ordnance Region is included in this district.

Cleveland District

One of the largest Ordnance district offices is located at Cleveland, Ohio, and by special arrangement with the War Department it is possible for the first time to give some description of the field work required by the country's newest and all-encompassing industry—war.

The Cleveland Ordnance District, which controls operations in northern Ohio and in northwestern Pennsylvania, has one of the widest "spreads" of any such district. It produces on primary contract or subcontract about 5,000 of the 13,000 items listed in the Ordnance Department's requirements. The Ordnance Department procures everything with which men fight except airplanes.

IN THIS district are tank factories, gun factories, producers of gun carriages, binocular manufacturers, the whole list of automotive equipment, to name only a few of its products. Its business is approaching the rate of $1,000,000 a day and probably will exceed $5,000,000 a day before its peak.

Col. H. M. Reedall, deputy district chief, is the energetic director of this Government business enterprise. He smiled when he was asked to give examples of conversion of industries that had turned figuratively from manufacturing plowshares to forging swords.

"Every job we have in manufacturing military requirements is a conversion one," he said. "The man who has made electric irons must be taught to make a new product. Machines to bore gun barrels have no use in civilian manufactures. A gun carriage is an individual product."

"What do you have to do to convert factories?" he was asked.

"We have to find skilled management primarily," he replied. "If management can do one thing well, it can learn to do another, if it has the right tools and the workmen and accurate plans. There is not much difference between one product and another if a manufacturer can work from plans. It is easy to change over the big companies. The problem lies with the small subcontractors."

As one example of a large conversion which has been virtually completed, he cited a large tire and rubber company which adapted the machines with which it had been making tire molds and beer barrels to the manufacture of gun carriages on a quantity basis. The type and quantity are a secret, but these carriages—far more complicated than the guns themselves—cost $8,000 each, which gives an index of the multiplicity of their parts. A plant which used to make electrical refrigerators is turning out binoculars. An automobile company now makes no commercial cars.

Not very long ago, the War Department sent out the specifications for the recoil mechanism of a British antitank gun—a difficult job. A number of manufacturers studied the venture. Then a machine-tool company which had been making molds for the rubber industry, took the primary contract. This job is going forward, assisted by seventeen

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subcontractors who perform seventy per cent of the total operations.

ANOTHER problem arose with orders to manufacture a type of British field gun entirely different from the American types. In this case, original estimates called for $1,750,000 worth of machine tools. The job was adapted to second-hand machines which were procured for $450,000. Fifteen companies are involved in mass production, through subcontracting, of a 37-mm. armor-piercing shell designed for use against tanks.

It is proverbial that large-scale Government operations and extreme expansion of programs in war time involve waste and duplication, but studies of the methods set up in this Ordnance district reveal multiple checks to hold this waste to a minimum. There is an informality also noticeable in contrast to the red tape that so often marks bureaucratic operations. Colonel Reedall meets contractors for conversations and not for formal conferences. When they have submitted padded bids, he has ordered these bids scaled down and showed how to do it.

There have been many occasions when small manufacturers, who have not realized the scope of new ventures, have made bids on which an expert could see they would literally "lose their shirts." In such cases they have been advised to raise their bids. There is no altruism in this advice, for a contractor who "goes broke" in the middle of a job is more of a liability than an asset.

The office records here show virtually no cases in which contractors have defaulted, although the greater number by far are small and heretofore inexperienced operators on the things they are producing. This is one of the regions where cluster the little manufacturers, as well as a few large ones.

For the making of war matériel in this district there are about 350 primary contracts and more than 5,500 subcontracts. These contracts, of course, interlock and are held by considerably fewer companies. Operations today cover 640 plants.

THE Ordnance district office over which Colonel Reedall presides has mushroomed from a skeleton staff only eighteen months ago, when he was transferred to Cleveland from St. Louis, into an organization embracing 1,800 persons. This staff is spread over much of four floors of the Terminal Tower Building, and is growing constantly. In the staff are about fifty Army officers trained in ordnance operations. Among the civilians are engineers, accountants, lawyers, and industrial specialists whose salaries for work-weeks ranging to sixty hours or more are fractions of their former incomes. These are men who for the most part have been asked to volunteer their services and have "signed up" for the duration.

In secret files that fill whole series of offices are 50,000 drawings covering about 5,000 of the 13,000 items of ordnance equipment, with specifications, standards, and the most minute requirements. Supplementing these drawings, which were made by engineers for engineers, is what Colonel Reedall calls his "peddling room." Here are displayed the actual parts of the wanted equipment, and Colonel Reedall gathers in the room small manufacturers to determine from the parts what their machines can do or be adapted to do. Frequently Ordnance engineers suggest means by which the manufacturers can adapt their facilities. Statistics, filed in binders, reveal as nearly as possible all the machine tools in the district and the numbers of men qualified to work them. Likewise recorded are the extent of training facilities to provide new workmen and the potential supply of additional tools.

"We have pretty well filled up the critical machine tools with production," Colonel Reedall declared. "Soon we shall have to use the marginal producers. The cost will be higher, but in this thing the only result that counts is production."

THE Ordnance Office here owns about 30,000 gages used to check matériel. Some of the gages test tolerances as small as one ten-thousandth of an inch. The gages are used primarily by inspectors in the plants. Sometimes the plants, which have to use similar gages in production, cannot obtain them and the Ordnance district office lends its gages. There have been occasions where the office itself has had to borrow from manufacturers. This is part of the interlocking coöperative side of the Government-industry production picture in the field.

These gages are the instruments which make possible mass production by use of subcontractors. Any particular item which passes the gage test will be interchangeable with a similar part, even though manufactured 1,000 miles away.

The office holds classes to teach inspectors how to use the gages and check on quality of production. One section of the offices is used by plant inspectors, who travel five days a week and write reports on the sixth. They look for everything from minor fire hazards to human hazards and study every element of plant security. Their faithful and painstaking attention to their arduous duties has resulted in the saving of many man-hours of urgently needed production time.

The contract division has been enlarged greatly as a result of an order from Washington authorizing district offices to award contracts involving less than $1,000,000, without reference to Washington.

A finance division was established early in last January to act on another order permitting prepayment up to fifty per cent of contracts. This was done to finance small manufacturers who have no bank credit to undertake initial orders.

A staff of auditors keeps daily track of expenditures, checking cost estimates against manufacturers' statements. A priority staff runs down critical materials as need arises, operating with the major agencies in Washington.

When a critical situation arose in the Cleveland district recently because of a shortage of scrap essential to the making of steel, municipal authorities coöperated in a "scrap hunt" which yielded 28,000 tons. One figurative gold mine of scrap was uncovered in a long-forgotten dump covered by a field of weeds.

Each day sees new tools, new workers, and new facilities brought into the picture, while officials and management increase operations toward the goal of three shifts seven days a week in every matériel supply factory.

That goal is far from achieved. This story, however, is written on a week-end, when customarily fires would be banked in factory furnaces and workers would be on a holiday. But there is a smoke pall over Cleveland through which one catches only glimpses of blue sky.

A visit to the factories here reveals no sight of spectacular bombers or the imagination-stimulating smaller combat planes, but what can be seen are the cumulative thousands of increasing activities necessary to supply an army which by the end of 1942 will contain 3,600,000 men.

New York Ordnance District

WITH a quiet efficiency that goes almost overlooked in the more dramatic reports of war efforts, the industrial community in New York and near-by New Jersey is contributing most of the precision manufactures required by the nation's arms program. It is estimated that this production in precision operations ranges as high as eighty per cent of the nation's total.

Printing-press manufacturers have retooled to produce recoil mechanisms for guns and to turn out machine tools; a sewing-machine company makes fire-control instruments in wholesale quantities, and a large brassière company has turned its talents to the manufacture of the small silk parachutes which are used to suspend flares and mines dropped by airplanes.

These are examples of the work of the New York Ordnance District, headed by Col. John K. Clement, which orders, instructs, and supervises the manufacture of whatever things can be made here to assist in providing equipment for the Army.

Colonel Clement, a distinguished Regular Army Ordnance expert, was assigned to the New York Ordnance District in 1937. His staff then consisted of two clerks. Today his district has a personnel of 1,400 persons, including 56 officers. It is handling 850 primary contracts with an aggregate value of $240,000,000 and more than 1,000 subcontracts.

The New York Ordnance District is geographically one of the smallest among the thirteen in the United States. It includes Long Island and the region bounded by Connecticut on the east, Poughkeepsie on the north, and Trenton, N. J., on the southwestern corner, but does not embrace Trenton.

In the offices of the Ordnance district, five civilian coördinators devote full time and overtime to the work. Illustrative of the type of executives coöperating in this all-out production effort are these five:

R. H. Watson, coördinator of production—since 1936 vice-president in charge of operations of the United States Steel Corporation; Elgood M. Lufkin, coördinator of contracting—vice-president since 1936 of the Bank of New York; Whitney Stone, coördinator of administration—executive vice-president of Stone & Webster and director of engineering and utility corporations; Frederick Tompkins, coördinator of purchasing—secretary since 1921 of Bates Kalsomine Company, corporation director, and since 1931 president of Tompkins Tidewater Terminal; F. Malcolm Farmer, coordinator of inspection—distinguished engineer and vice-president since 1929 of Electrical Testing Laboratory.

Because it must instruct and coöperate with manufacturers rather than simply order from them, the Ordnance District offices include divisions covering manufacturing service, inspection, property requisition, and the highly secret mission of plant protection. Contracts as large as $50,000,000 have been placed in a single working day.

The New York Ordnance District came into being in 1922 in a room of a building on Whitehall Street. That was the beginning of a job of industrial surveys that culminated in records that today are a "bible" of war production in this area. This "bible" is a filing system with 3,500 cards. Each card represents a manufacturer. Punch marks on its margin show precisely the machine tools possessed by each unit, their type and number, whether 2 or 3,000. Now the cards are being re-sorted to break down the types of machines into subcategories. When an order comes from Washington that requires perhaps a milling machine, a vertical drill, and three other special machines, the cards help in finding the place where these machines exist.

An Ordnance district engineer arranges a meeting with the small producer and usually finds he is not very skilled, cannot estimate his own requirements in a brand-new type of work—perhaps cannot readily read precise blueprints. So the engineer takes the manufacturer to the "sample room" where parts of everything made in this Ordnance district are on display. Then the manufacturer can understand the job.

What may be needed in the way of new machine equipment is obtained as quickly as possible by the Ordnance district for the account of the new contractor; a field agent teaches the new contractor the requirements of high-specification work; an official inspector tests the final product for accuracy—and there is created a new war industry. The process is expensive. It takes time. It involves waste. But the war-production program already has passed the stage in this and most other districts where the highly skilled, highly efficient large industries are available for further contracts.

The bottleneck in machine tools is exceeded only by the bottleneck in production and managerial experience and ability. And yet the war production requirements pouring into Colonel Clement's office alone increase at the rate of twenty per cent each month.

Today, the office is inspecting more than 2,000 current jobs, while it resurveys facilities, checks and revises production requirements, and fights to keep its actual output abreast of schedules which were designed on the basis of most efficient operations.

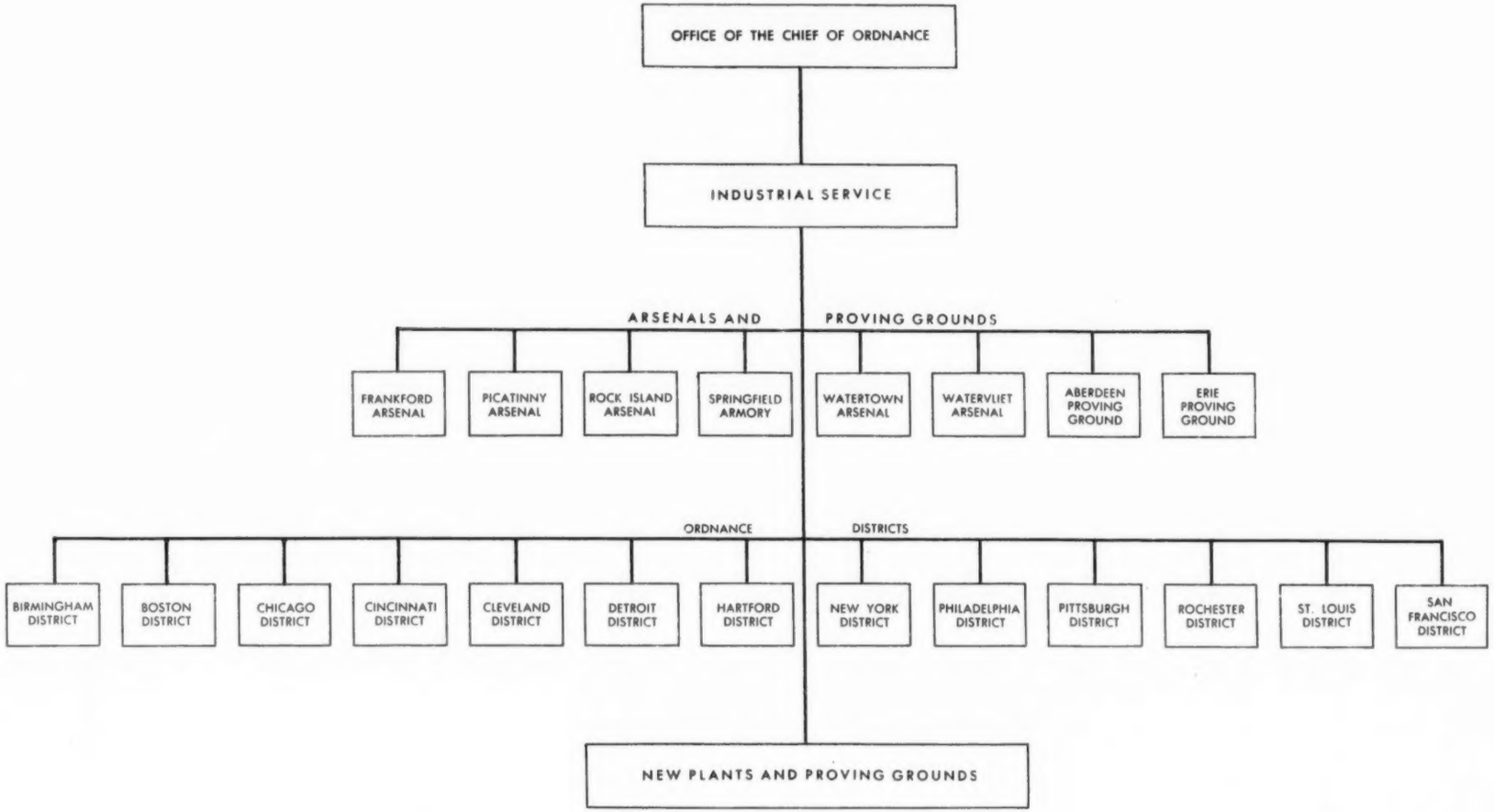
OUT of some 13,000 ordnance items—all the things with which men fight on the ground—this district produces about 450. The manufacturing secrets of these 450 are drawn into a set of more than 15,000 blueprints, which also are being constantly revised, on orders from Washington. Colonel Clement estimates that among the 3,500 manufacturers in the New York metropolitan area, about 500 are working on contracts for critical materials, and another 500 are involved in producing related items. Another large group is doing subcontracting work.

Every bit of expansion which now takes place—the original available and equipped producers having been exhausted—requires much pioneer work and particularly new machine tools. And machine tools are more precious than diamonds. One result of this need has been the creation of a machine-tool industry in the New York Ordnance District. These are manufactured by companies which never have made them before but whose skilled managers and workmen possess the "know-how" so essential in making the machines that make the war machines.

The war materials produced here in the greatest amounts actually are those for which no conversion of civil industry was required. Most important among them are motors for tanks and transmissions for tanks and heavy trucks. The headaches have come with the specialty requirements.

As one result, a large industry has been created to make optical goods of the highest type—the range finders necessary for accurate operation of antiaircraft guns. No private manufacturer hereabouts ever had made cannon, or the recoil mechanisms for them that are far more complicated than the guns, but these today are being produced in measurable and increasing quantities.

ORDNANCE PRODUCTION ORGANIZATION



Two large companies that formerly made machinery used by newspapers, such as rotary printing presses and automatic type-setting machines, are producing the optical instruments noted above. A large manufacturer of sewing machines has switched to the production of instruments, other than optical, by which fire control of batteries of cannon is directed.

A large elevator company is turning out recoil mechanisms for guns and machine tools. Three manufacturers of rotary presses are making recoil mechanisms and machine tools. A company that made flat-bed printing presses and a type-setting machine company now are making together recoil mechanisms and cannon. The breech mechanism for these cannon is subcontracted to another company that formerly served the mechanical needs of newspapers.

A manufacturer of pneumatic door closers has adapted his metal-turning machinery to a number of things, including 20-mm. and 37-mm. shells. Three companies that made fireworks for celebration purposes now make flares and other pyrotechnics for the Army. The products are quite different, but the same skills in handling explosives apply to each. A safety-razor manufacturer and a battery manufacturer are making shells, while a water-meter company makes fuzes for these shells.

This is the real meaning of conversion of industry for war.

Large as the work is, officials say that what has been accomplished is only the beginning. A year from now, it is quite probable that this work, which already has changed the face of New York City's industry, will seem little more than a pioneering gesture.

Philadelphia Ordnance District

A FINE example of the conversion of machines and skill from civilian manufacture into war production is to be found today in the Philadelphia Ordnance District, which includes the Philadelphia metropolitan area, the region north to Trenton, N. J., and eastward and southward to the Atlantic.

Without any impressive new construction, with few machine tools, and more improvisation than this writer has observed in other Ordnance districts, this one is rapidly working on what promises soon to be a billion-dollar arms commitment. Within a year, deliveries of ordnance have multiplied more than twenty times, while factories turn out at ever-increasing rates all types of fighting equipment for the Army—from bullets to tanks.

This is the district where mass production of tanks of the medium and light types has become an accomplished fact. Within a few weeks, heavy tanks will come off assembly lines in regular order. This district had contracts totaling about $700,000,000 at the time of this writing, and new commitments of about $150,000,000 were expected. There were yet to be assigned new shares of production under the Fourth Supplemental and the Victory programs.

In the immediately important field of actual deliveries, the writer was shown records detailing deliveries in January of matériel worth $22,176,000. In January of 1941, deliveries by this district were $953,000. In last July, the deliveries rose to $6,441,000, and in October to $14,250,000. The present rate will be doubled by summer.

As with the other twelve Ordnance districts, the Philadelphia area has about exhausted all potential supplies of machine tools, and it long ago ran through the list of manufacturers able to take on contracts for which they were fitted. Yet improvisation has apparently been used to an extraordinary extent, together with adaptation of methods which have something in common as between peace and war usage.

An outstanding example of such is a plant which up to a few months ago manufactured steel burial vaults. This work required welding units, heavy cranes, and a large working space. The company does not make burial vaults any more. Its floor area occupied with parts of tanks which its workers weld together, it has become a tank subcontractor without buying a single new type of tool or rebuilding its factory.

The deputy chief of this Ordnance district is Col. D. N. Hauseman, who came here a year and a half ago to take over an office with personnel consisting of about thirty persons. Last pay day his staff consisted of 2,001 persons, principally civilian engineers who place contracts, teach standards, and inspect finished products, as well as constantly "push" production to hold established schedules. With this staff, the Ordnance district is administering 598 prime contracts and 7,481 subcontracts, at the last accounting. It frequently places new contracts within forty-eight hours after receipt of instructions from Washington, and is now concentrating on enlargement of deliveries in every field.

The tanks produced within the district form the largest share of its commitments, but the "sample room," where contractors come to see what they may be able to make, is practically a museum of the implements of war. In it are the parts for half-track trucks and cars, for gun carriages, for 75-mm. guns and 90-mm. antiaircraft guns, for 60- and 81-mm. mortars, for bombs of every size and type, for shells, cartridges, fuzes, flares, and machine-gun mounts and armor plate.

SUBCONTRACTING reaches its peak here in the production of medium tanks by a large manufacturer who, under war regulations, may not be named. This manufacturer uses 211 principal subcontractors, and these in turn are assisted by 1,056 sub-subcontractors. These figures do not include suppliers of raw materials. Probably the smallest of the "subsubs" is an automobile maintenance garage which uses its lathe to turn a small rod that props open the door of a tank porthole.

The tank company, incidentally, has demonstrated that machine-tool bottlenecks are not necessarily as critical as might be assumed from general reports. When it received the first large order about a year ago, it set down a formidable list of requirements for new special tools. It has not yet received all the requested tools but in the meantime has stepped production up to ten times the original rate. Subcontracting had a lot to do with that, according to Colonel Hauseman. "We can handle a lot more work here," he said. "Many manufacturers have not been put to work on war orders."

There are numerous examples of conversion, which often have been made easier by the adoption of practical rather than ideal requirements.

Thus, a bathtub manufacturer is now making 75-mm. shells and a mousetrap company is turning out plugs for fuze holes in shells and bombs. A cork manufacturing company uses its machine to turn out shell and cartridge cases and bomb clusters—racks in which small bombs can be placed as a unit for attachment to racks in bombers. A baking-machine company produces trench mortars and shells, while an automobile-frame company is making gun

mounts. An ice-machine company is turning out machine tools, while a safe-and-lock company is manufacturing shells. One bottling company swung to the production of machine-gun mounts without scrapping one of its original tools, although it necessarily needed some new ones in addition.

Rochester Ordnance District

AMONG the thirteen Ordnance districts into which the United States is divided, the Rochester District is far from the largest, but it is one of the most important.

The pioneering work of the partnership of Bausch & Lomb in the middle of the last century created in this city the only factory making optical glass in the United States, until defense experiments last year encouraged creation of similar industries elsewhere in this country.

Comparably, the Kodak development by the late George Eastman became the nucleus for far-reaching training in precision skills, adding to other less spectacular industrial growth in this region.

The Rochester Ordnance District, which embraces all of New York State north of Poughkeepsie and includes Buffalo, has not yet reached capacity in assignment of war orders. Industrial costs in general are high, and labor commands wages which make ordinary competition with many other industrial areas difficult.

Nevertheless, what this district lacks in quantity it offers in quality workmanship, with the result that it now sends optical glass to scores of other factories making all types of visual instruments for war; it produces the precise range finders for warships and antiaircraft batteries; tanks roll in steady procession from an operating factory, and many plants are in mass production on machine guns, bombs, fuzes, antiaircraft guns, gun mounts, rifles and pistols, as well as a host of smaller items. The great bulk of this work represents factory conversion from peace-time requirements to war needs. In other cases it is an adaptation of skills, some of which had lain dormant for years.

One factory working at the highest possible speed on range finders, which combine the finest optical lenses with intricate calculating mechanisms, could use 2,000 more workmen immediately if it had them. The trained men are not to be had, here or elsewhere in the United States, so training schools are rushing them into jobs. Subcontracting of parts of other mechanisms is going forward but always with the recognition that this operation is more expensive and makes more demands on the Ordnance Department itself for trained supervisors and inspectors to check the components being made in widely scattered plants.

Like the other Ordnance districts, that of Rochester consisted in 1937, when Lieut. Col. Roy L. Bowlin took command, of a couple of officers, a secretary, and a sheaf of records of potential war producers. Its personnel today includes 546 civilian ordnance inspectors and 505 other civilians. The district chief, a civilian who advises Colonel Bowlin, is Erwin R. Davenport, a newspaper publisher.

This office, and a suboffice in Buffalo, have been letting contracts since January 1st at the rate of $1,000,000 a day. One peak was passed in contract letting late in 1941. Outstanding ordnance contracts now supervised by the office total $403,000,000, and are being filled by 105 companies. A further bulge came when the district got its allocation of work to be done under the Fourth Supplemental and the Victory appropriations.

In addition to the prime contracts, the Ordnance district office is inspecting at present several thousand subcontracts issued to 1,422 companies which are assisting with $168,200,000 of the ordnance operations in this area.

Behind these contracts is a detailed survey of industrial facilities in the Rochester district, which yielded the conclusion that 190 manufacturers had facilities and man power suitable for war manufacture out of a total of 767 companies that were studied.

Talks with officials and private contractors indicated that the Rochester Ordnance District, in common with others, has recently shown a new and enlarged interest in war matériel with the clamping down of priorities and allocations which have cut sharply the potential production of consumer goods. Manufacturers who formerly were reluctant are now clamoring for business.

Incidentally, Bausch & Lomb, the great maker of optical lenses, which range from minute ones for telescopes to 5-foot curved lenses for giant searchlights, was particularly commended both for the speed in which operations were converted to national needs and the manner in which the company gave its trade secrets to other companies. There are no patents covering the manufacture of optical glass, it was explained to the writer. The process has been protected through generations simply as a trade secret. It was explained, in addition, that this type of glass is so fine that it compares with the glass used in spectacles in about the same degree that spectacle lenses compare with window glass.

WHEN the writer visited the plant where optical glass is made he had to have credentials far more detailed than those necessary to visit the War Department in Washington—so great is the precaution against sabotage. Once in the plant, he encountered a strong Germanic flavor of names and dialect among the skilled workmen, for Germany is the country that has developed workmen devoted to the science of optics in greatest proportion. All these workmen, however, are Americans. Their ardor has been amply demonstrated by the expansion in production rates since December 7th.

The craftsmen who work on range finders are probably the most highly skilled of all workers. One large range finder is probably 1,000 times as large as a miniature camera and even more exacting to manufacture.

Subcontracting is a comparatively recent development in the general field of arms manufacture, created partly by public demand for a spread of the benefits of the work and more recently by a demand for speed not even conceived a year ago. One record sheet at which this writer looked illustrates the spread of this movement. It was said to be a typical example. The contract involved was one for $10,000,000 worth of an extremely critical item. It originally was given to one company, which in time could have filled the order with its own men and machines. Under the new program, $7,000,000 worth of the work was put out on subcontracts, divided among 172 subsidiary manufacturers. Of the subcontractors on this one order, 145 are in New York State, several are in Pennsylvania, and the rest are scattered, with one subcontract being filled as far west as Missouri.

There are numerous examples here of outright conversion, one of which is furnished by a manufacturer of washing machines, a product no longer made in the United States. This company, with a $5,000,000 contract, has already started production of shell fuzes on its original machines and soon will be making machine-gun mounts. Thus the Ordnance districts are meeting the test of war production.

These Also Bring Victory

Ordnance Inspection Personnel Include Many Professions

Lieut. Col. H. S. Wilkins*

FOR many years, the Picatinny Arsenal has conducted a summer training camp for selected Reserve officers and young officers recently detailed to Ordnance. Occasionally a very few ammunition surveillance inspectors also were given training. The large-scale training of civilians for other establishments began, however, with the expansion of the Ordnance district offices early in 1940. From a status of one officer and a stenographer, engaged largely in planning and contact work, these district offices first took over the inspection formerly conducted by the arsenals and, later on, procurement and numerous other activities, resulting in an enormous but orderly expansion. Their first need was for trained men; however, only a very few existed, and it was therefore necessary for the districts to send their new employees to the arsenals for training, prior to entering active duty.

In this manner, the present training school at Picatinny Arsenal, now having an average attendance of 150 to 200, with over 2,000 graduates, began with a group of 15 or 20 inspectors from various district offices. With the construction of the enormous new smokeless-powder, explosives, and loading plants, there developed the need to train Government inspectors and the operating and inspection personnel of contractors. Except in the case of one contractor who already had in operation his own privately owned plant, key personnel for all the other plants were sent to the training school at Picatinny. At first these were largely Government employees, but at present the reverse is true.

Training headquarters at first were in a corner of the inspection office, using as equipment some old-fashioned schoolroom desks salvaged from the school formerly conducted for children of the resident post personnel. These quarters soon became inadequate. Space anywhere in the arsenal was at a premium, and for a time an outdoor class in the apple orchard appeared the only recourse. At this crisis, the post personnel sacrificed their winter exercise to the emergency, and the school moved to the badminton court. Before long, these quarters also became inadequate, and some classes overflowed into the adjoining overnight quarters for transient visitors. Here a typical sight was to see the instructor standing in the narrow hall with students crammed into the kitchenette and dining room and even peering from the shower bath (fully clothed), anxious not to lose a word.

Recently the building program at the arsenal has been completed sufficiently to provide fine new quarters, with a large assembly hall sufficient to accommodate the entire school at one time, two medium-sized classrooms, and an office for the executive officer. Each graduating class had its photograph taken and the long frieze of these extending almost the full width of the new assembly room gives a graphic idea of the number of classes which have now been graduated.

From the first, it was felt most strongly that the basic principle of the training should be to give the students first-hand contact with actual operations in a going establishment. Book study could be almost as well accomplished at the home plant. To give the students a proper picture of the problem, however, their courses begin with three or four days of classroom work. Here they are given a lecture on safety, warned of the requirement to provide themselves with safety shoes, and are instructed in the other details of conduct necessary for any one working in an explosives plant. They are also given lectures about the matériel they will see later in the plant, told why a left-hand thread is used here, a right-hand thread there, about the mysteries of set-back, creep, etc.

After this preliminary instruction, they are assigned to the various operating buildings in groups of two or three to six, preferably in as small groups as possible. To distribute 150 men so that not more than 6 of them will be in any one building is a rather intricate administrative job. Owing to the limited time and facilities, it is a requisite that the specific training desired for each man be specified prior to his arrival at Picatinny Arsenal. Time is lacking for general training, and emphasis is therefore placed on teaching each man only about the specific job on which he will be engaged.

IN the plant, the trainees are under the instruction of the arsenal operating foremen, and, whenever conditions permit, take their places in lines and perform each operation until they become reasonably proficient. Some trainees at first thought this beneath their dignity, but soon all saw the advantages. The example set by some of the most dignified, however, soon became the willing habit of all. On one occasion, in a check of trainees, a close relative of a chief executive of one of our largest corporations could not be seen. Inquiry disclosed that he was inside a transfer car shoveling out nitrocellulose. This and the rest of his practical experience received here has since stood him in good stead.

To properly instruct others, one must know how to do the job oneself. To attempt to learn by merely watching others is sometimes the only way possible, but this method cannot be relied upon. The author recently had his prior conviction of this fact confirmed to his personal embarrassment. Jenkins, his faithful colored servant for the past eleven years, had successively and successfully taken on the duties of stableman, chauffeur, butler, cook, housekeeper, and gardener in the order named. There appeared to be nothing he couldn't do, and he attributed his success to carefully observing just how these functions were performed by others. Under the present pressure, it is difficult to find time to get one's hair cut, and I therefore let Jenkins try his hand at this—with appalling results. Except for the war, I would not have appeared in public for weeks.

At first, instruction was given by the regular personnel of the arsenal's inspection department, with practical instruction in operations by the shop foremen. With the growth in numbers of trainees, however, it soon became ap-

*Chief, Inspection Department, in charge of the training school for loading plants, powder, explosives, and metal components, Picatinny Arsenal. Lieutenant Colonel, Ordnance Department, U. S. Army.

CIVILIAN INSPECTORS' TRAINING CLASS AT PICATINNY ARSENAL

parent that a full-time staff was necessary. The administrative work alone, involving a complicated schedule of assignments, location of living accommodations, time cards, pay checks, personal mail, and numerous other matters, became a burden.

The first permanent member of the staff was Robert Lynch, from the machine shop. Educated in teaching methods at Columbia and Harvard, with several years' service in teaching at trade schools, he brought an understanding of teaching procedure. Edgar Holley, borrowed from the machine shop, with his long years of service at Picatinny Arsenal furnished the intimate knowledge of fuzes necessary in order to give the trainees a proper perspective of the job. Without previous experience as a teacher, Ed proved to be one of those rare people with a natural gift for imparting his own knowledge to others, and the way he puts his whole heart and soul into the work could not but fail to arouse the interest and enthusiasm of all. The many duties of administration were taken over by 1st Lieut. Wallace L. Kimball who, as executive officer, displayed the happy gift of a placid temperament, unruffled by the nonarrival of pay checks, the mysteries of preparing vouchers for *per diem* allowances, and trainees unexpectedly requiring hospital care. Lieutenant Kimball has since been worthily succeeded by Lieut. George Dobler, previously his assistant.

Last but not least, the vital instruction in the operating departments has been given, in addition to their regular duties, by the various loading-department and powder-plant foremen. With all the trying duties incident to an enormously expanding production, these men have shown rare patience and skill in imparting their own knowledge to the trainees.

Coming as they do from all over the country and from many walks of life, the trainees represent a broad cross section of the people who are carrying out the production program. There have been clergymen, a former professional boxer, city managers, college professors and school teachers on leave of absence, automobile, tire, and refrigerator salesmen, and managers forced out of their regular occupations by the war. There have been well-to-do middle-aged business men, with sons in the fighting services, too old to fight themselves but anxious to help their country in this way.

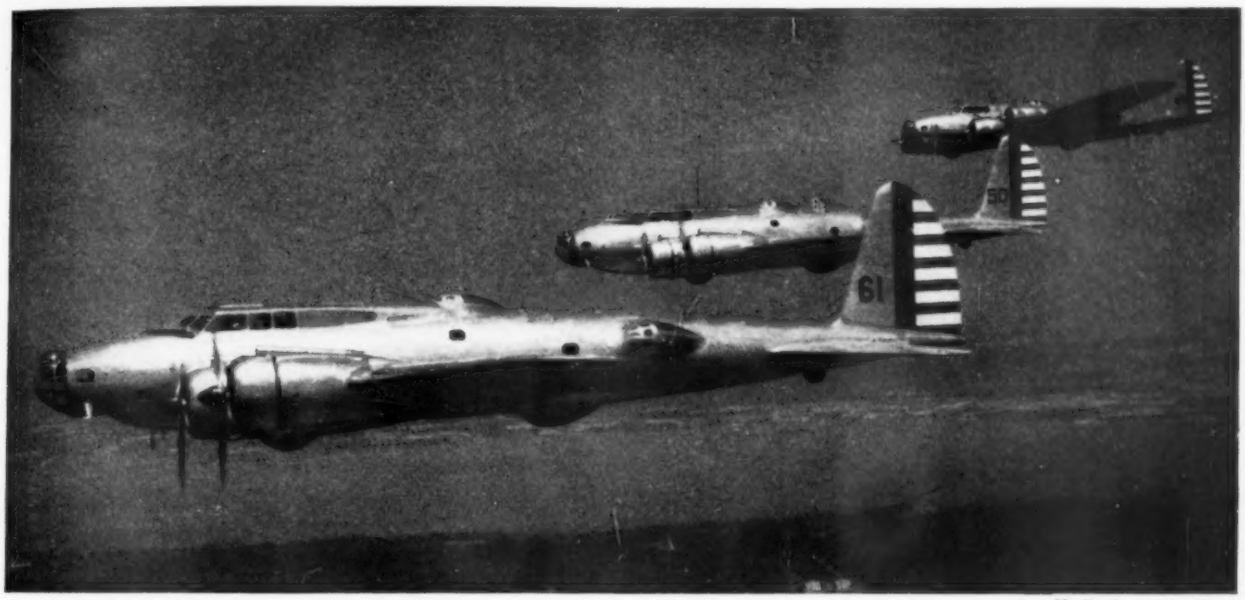
There also have been men who were outstanding in the world of sports: an All-American football star, another who played five years on the New York Giants professional football team, one who represented the U.S.A. on the Olympic team in the relay races, a recent national champion pistol shot, and the coach of an Arkansas girls' basketball team which won the United States championship. There have been World War officers with decorations and records of achievement. There have been Southern boys who regaled incredulous New Englanders with true stories of fish fries and methods of fishing unheard of in this section. A group of fishermen, they said with straight faces, stir up the mud in a section of a stream and then, armed with clubs, they hit the fish on their noses when they come to the surface to avoid the mud! There have been groups of midwesterners who saw the Manhattan skyline for the first time. There have been earnest and attractive young women, anxious to do their bit in the war effort by helping with the manufacture of the vital ammunition.

WITH the enormous increase in personnel at Picatinny Arsenal, living accommodations for the trainees at first appeared a serious problem. Tourist homes met the limited requirements for a time; then other unexpected quarters were discovered. A not-too-distant "dude ranch" was taken over by one group, and erstwhile defunct hotels on neighboring Lake Hopatcong again opened their doors. The proprietor of a hotel on Budd Lake, who ordinarily operated a Florida hotel in the winter, decided to remain North and provided transportation to and from the arsenal as well. Others found accommodations on the palatial former estate of the Ringling family of circus fame.

A strong spirit of comradery has existed among the trainees, evidenced by numerous picnics in the summer season and indoor gatherings during more inclement weather. Moreover, the graduates seem to have a great loyalty and affection for Picatinny Arsenal and the instruction staff. They speak of it as "Picatinny Arsenal College" and seem drawn together in this common bond, like the alumni of any typical American college.

Bombs

MODERN warfare has brought the airplane to the fore as an offensive instrument. The airplane, however, is not in itself a new weapon—it is but a new form of an old medium of warfare—artillery. In this new form, the internal-combustion engine has taken the place of propellent powder, and the bomb has become the projectile—but its range is over 1,000 miles instead of a mere 10 or 20.



U. S. Army Air Corps

Various types of bombs are employed by this air-artillery to meet different tactical conditions. Fragmentation bombs are thin-walled bombs, weighing about thirty pounds, so constructed that they burst into numerous small, regular-sized pieces on detonation. They are used chiefly against ground personnel in the open and against aircraft on the ground. Demolition bombs usually weigh from 100 to 2,000 pounds, and even heavier types are employed. They are thick-walled, burst into large irregular fragments, and have a heavy blast effect. They usually are used against military installations, fortifications, gun emplacements, factories, and other large solid structures. They are equipped with a delayed-action nose fuze to allow the bomb to penetrate some distance into its objective before exploding, and many bombs are also equipped with a tail fuze to make detonation more positive. Armor-piercing bombs are a special kind of demolition bomb, with very heavy walls, armor-piercing nose, and delayed-action fuze, and are used principally against armored naval vessels and concrete installations.

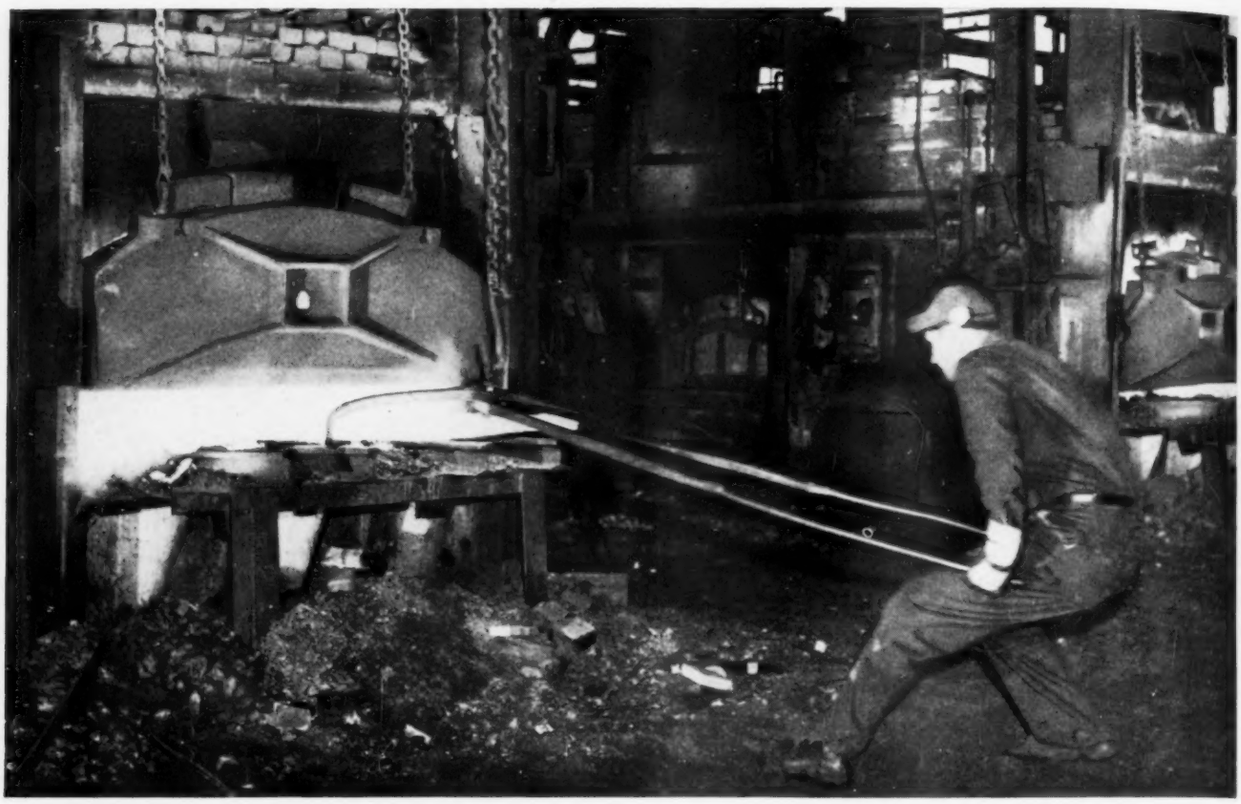
Aërial mines are high-explosive charges, weighing about 2,000 pounds, which are dropped from airplane by parachute. They explode on impact and have a tremendous blast effect, so that they are usually employed against densely built-up areas, storage tanks, and similar objectives of this nature.

Incendiary bombs are really a type of chemical warfare agent. The kind most employed thus far in the present war is the 2.2-pound magnesium bomb with thermit filler. Phosphorus and oil bombs are also used as incendiary agents.

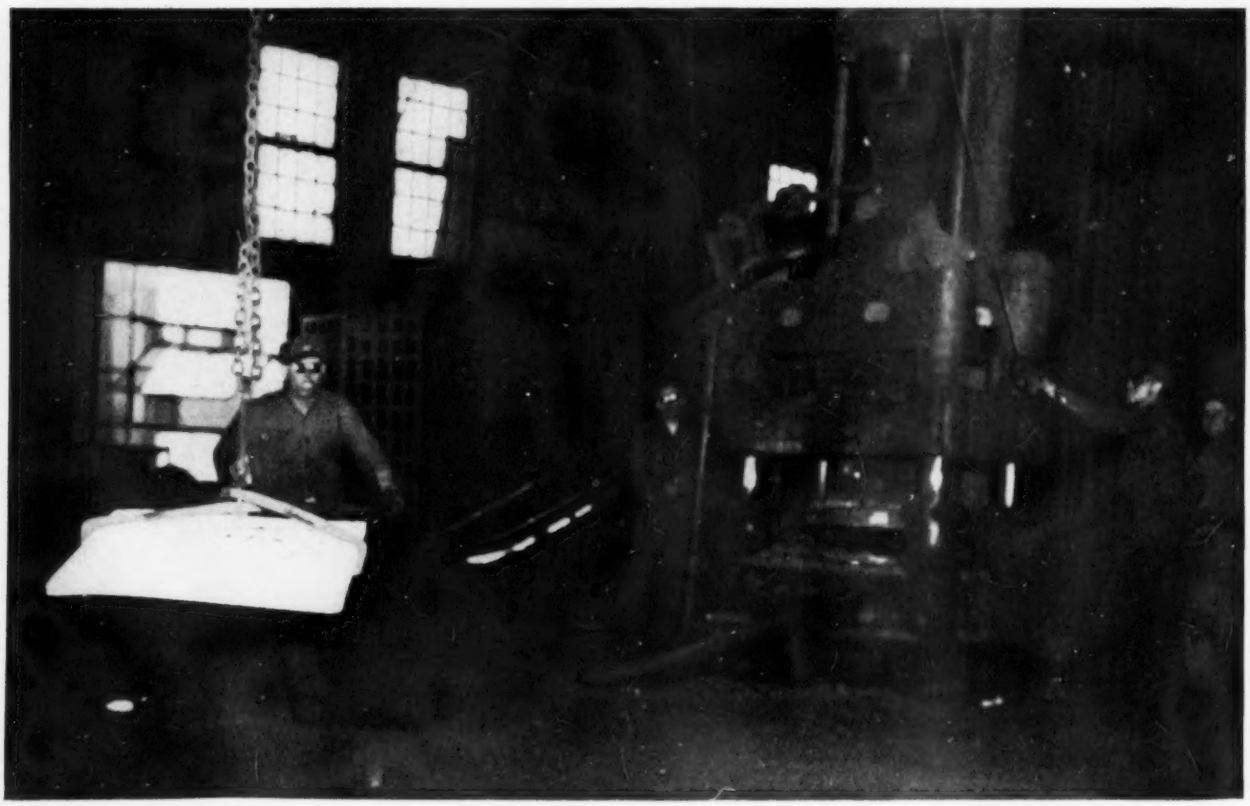
The 500-pound demolition bomb is a type frequently used in the present war. It has great destructive power for its weight and is much less expensive than the larger bombs. More of them can be carried by the bomber, increasing the probability of an effective hit. Contrary to popular opinion, these bombs are not punched out with the ease and rapidity of tomato cans. They are made of tough steel which must be heated, forged, and machined; the explosive mixture must be carefully loaded into them; they must be equipped with sensitive fuzes and a tail assembly; and finally they must be shipped to the air field and loaded into the bombers. Only then are they ready to do their bit for victory.

The following sequence of Signal Corps photographs shows some of the steps in bomb manufacture. Despite the size and complexity of the task, American industry is today turning out these formidable projectiles for our new air-artillery in an ever-increasing stream.

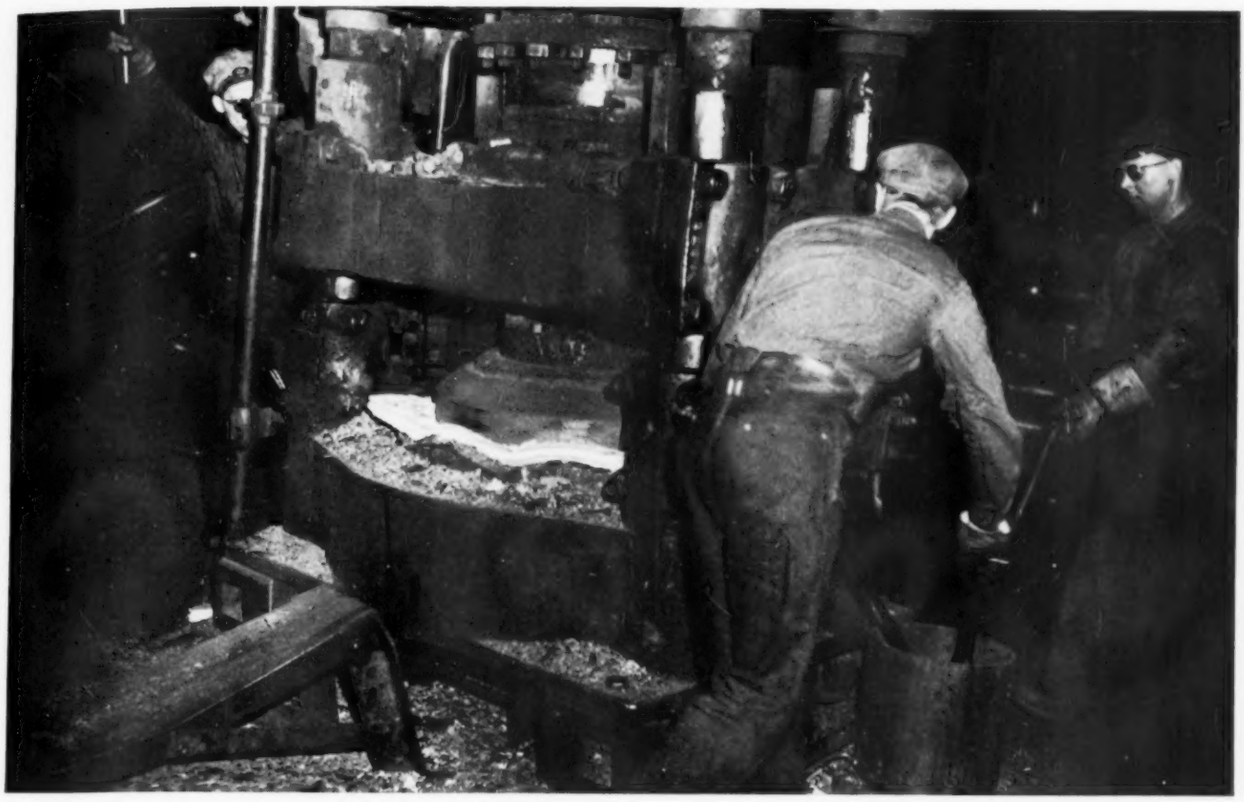
The Beginning of a Bomb



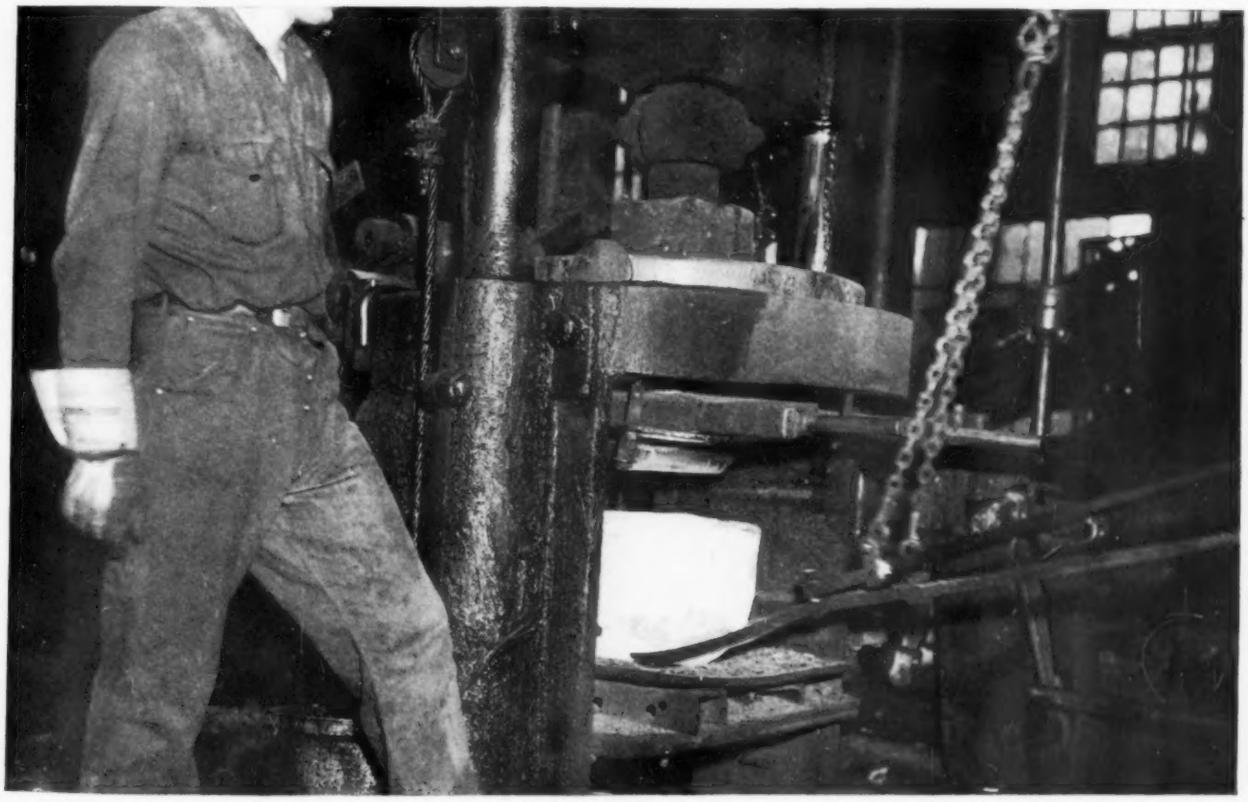
A 500-pound demolition bomb has its beginning as a white-hot slab of steel such as the one shown above being taken from 2,200 degrees of furnace heat at a commercial facility. The illustration below shows the next step in bomb making—transporting the plate by monorail carrier to the shearing press shown in the background for its first shaping.



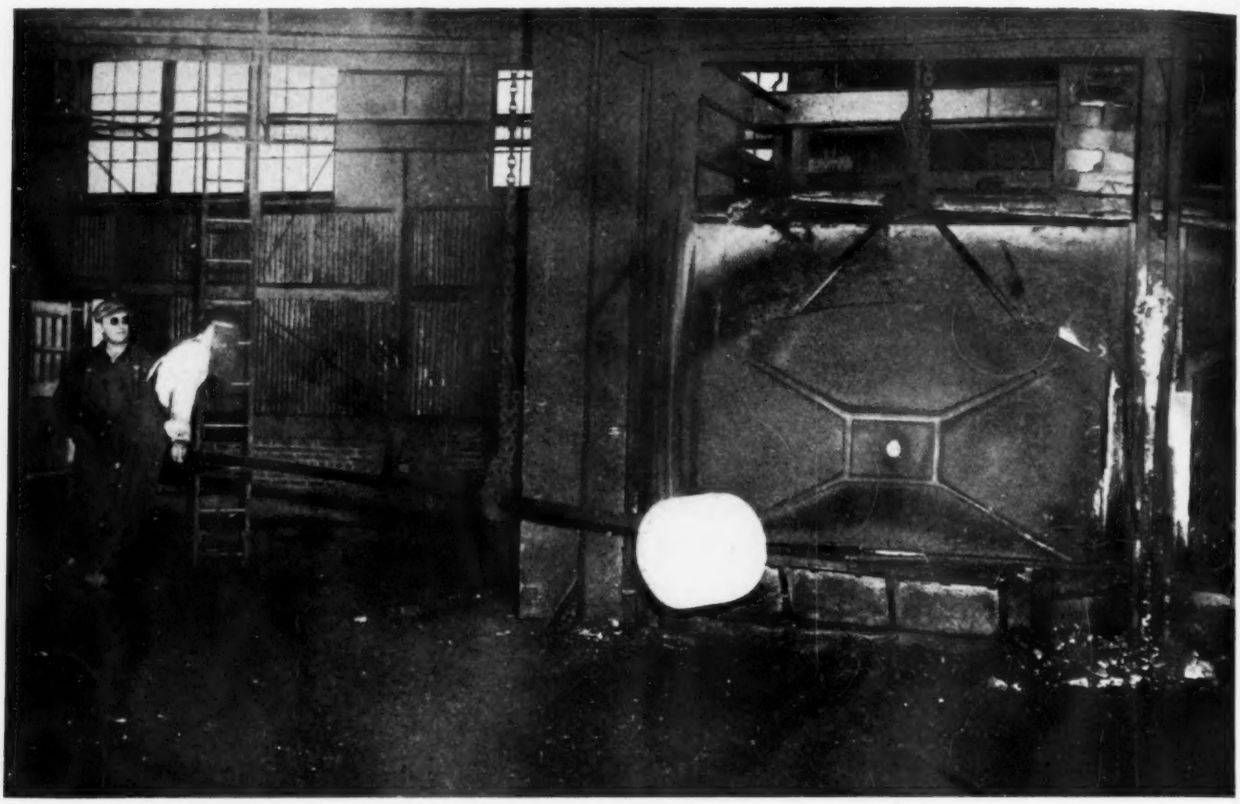
Forging the Cup



In the photograph above, the shearing press is shown in action as it descends on the white-hot plate, the edge of which is forced into a wavy line by the pressure. In the operation shown below, the plate has been formed into a shallow cup on a cupping press from which it will go to the first draw bench for further "stretching" to bomb shape.

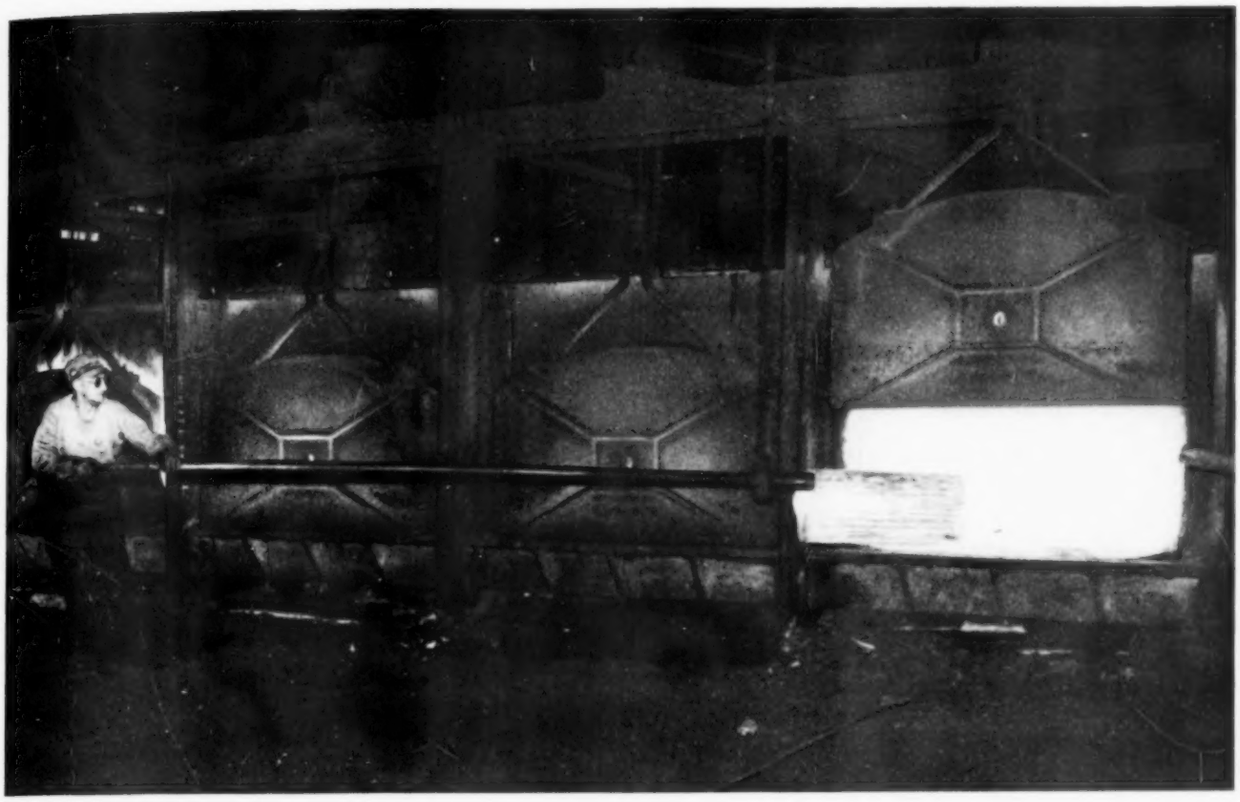


The First Draw

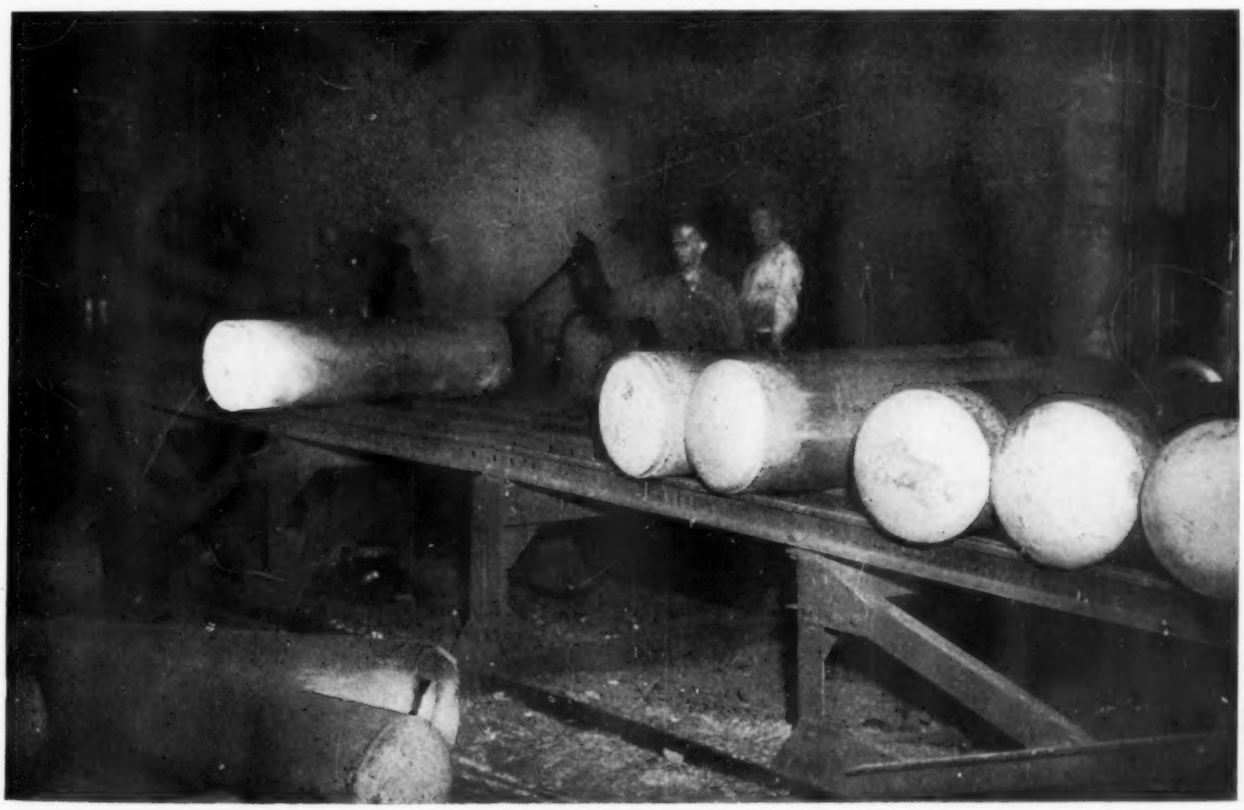


After reheating, the white-hot forged cup, above, is propelled by a mask-protected workman from the furnace toward the draw bench for the second forging operation. Reaching the draw bench, below, the cup is thrust into position, and the ram, paralleling the steel carrying bar held by the workmen, will move forward and "stretch" the cup.

The Second Draw

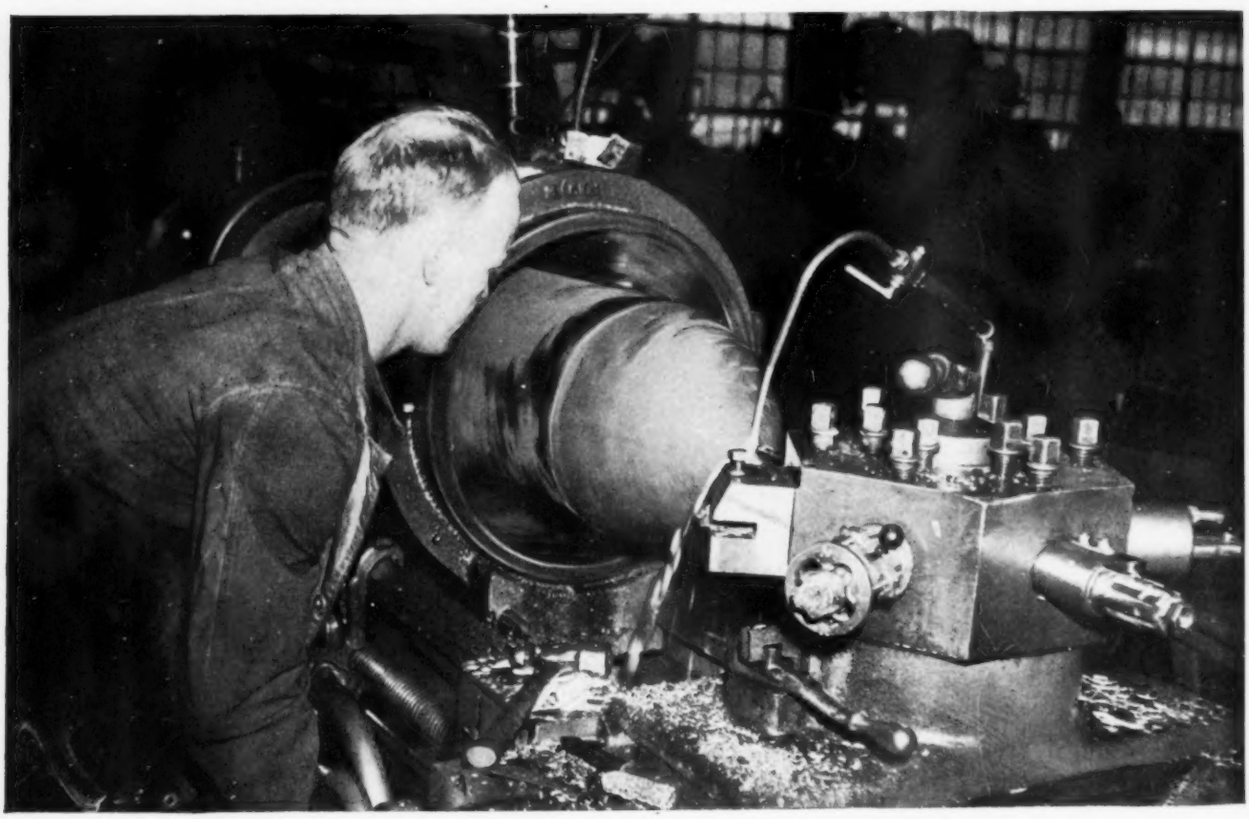


Stretched by the first draw, the steel plate is now beginning to assume a definite bomb shape and appears, above, as a closed-end cylinder as it is placed in a furnace for a reheat before the second draw. As it comes from the second draw, below, the cylinder has reached its full length and is now ready for the shearing press which will trim off the rough end.



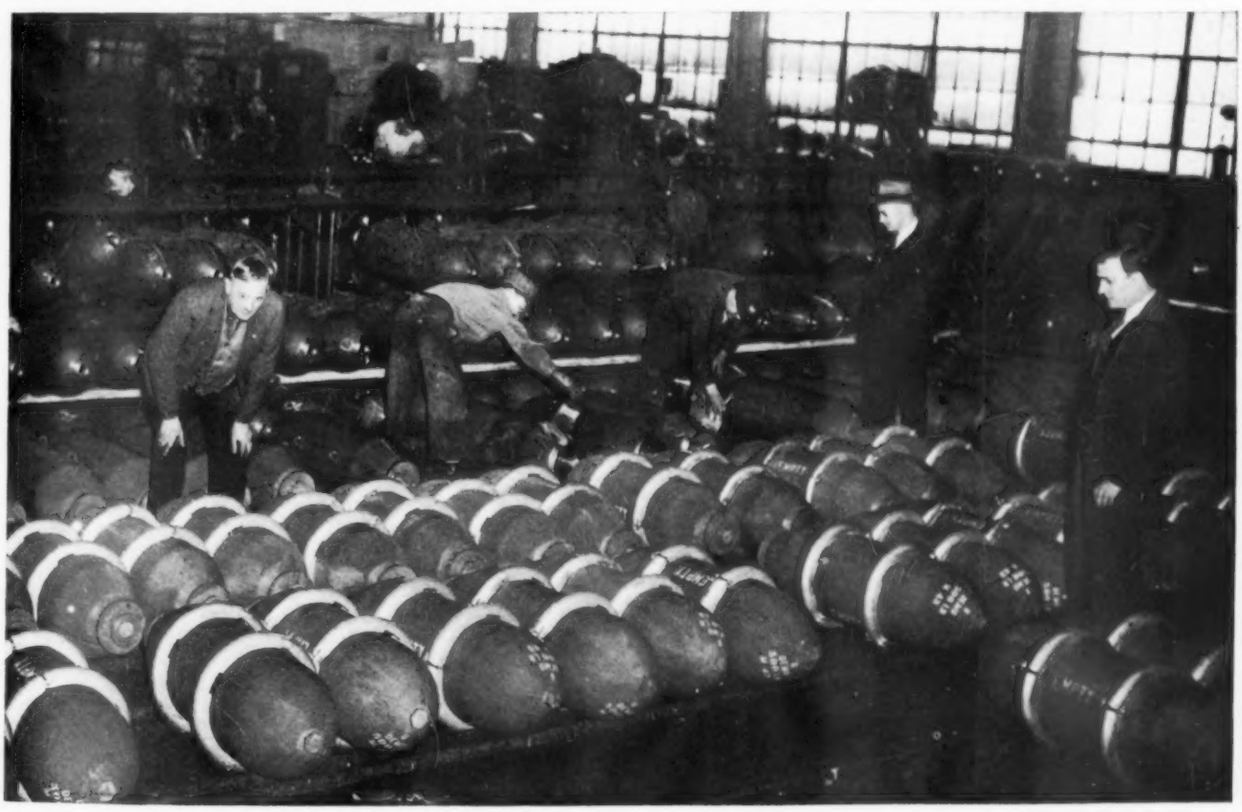
Trimming and Nosing the Bomb

The bomb is shown above about to be sheared at the forging mouth which will later be tapered to an opening through which the bomb will be filled with TNT at an Ordnance Department loading plant. The nose end is machined to a point, as shown below, and is prepared to receive a fuze which will be attached when the bomb is ready for actual use in combat.



Preparation for Shipment

The completed bomb bodies are shown above stacked and ready to be prepared for shipment. The bombs will be loaded later through the wide openings, or necks, and the fuze fitted into the nose shown above the workman's left foot. The bombs below have been capped at both ends and painted, and have had bands attached to facilitate handling in shipment.



The Bomb in Service

After being loaded, the bombs are ready for service. In the illustration above, a bomb is being hauled on a special trailer from the bomb dump to the air field where it will be loaded aboard a bomber. Below, the bomb has reached the field and is ready to be loaded into a Flying Fortress for its great and final mission—an effective hit (Acme photos).

Artillery Fuzes

The Systems Used in 37-mm. and 75-mm. Ammunition

J. B. Nealey*

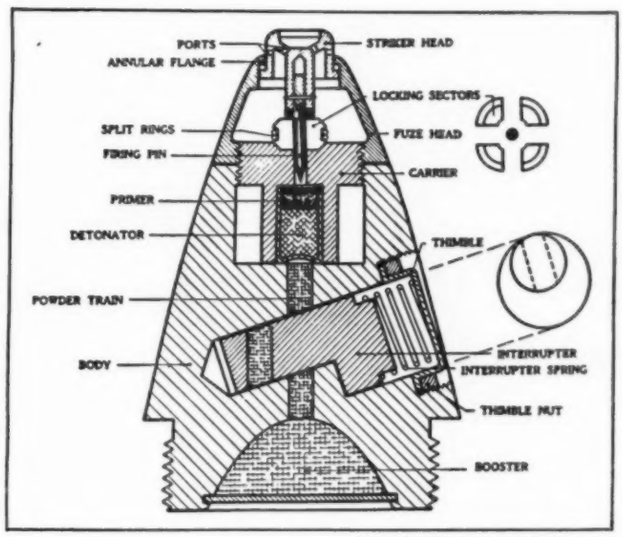
"A TRAIN of powder" is an expression that has come down through the ages; it describes the first known method of igniting a large charge of explosive at a predetermined distance. It was the first fuze and a natural outgrowth from the method of firing the early muzzle-loading guns in which a short train of powder extended from the propellent charge in the gun through a hole or vent in the gun barrel to a small charge held in a pan on the outside of the gun. This was ignited by a flame or hot coal and was used up to 1850. Powder was employed for blasting as early as 1200, and the fuzes used were probably of the powder-train type.

The first shell was a hollow clay sphere, baked hard, filled with incendiary materials and a charge of black powder to scatter them. These were used in the fourteenth and fifteenth centuries. The fuze (1450) was a hollow reed filled with powder. During the latter century, iron or steel shell containing an explosive charge of powder and a fuze were devised. To produce these, two half spheres were forged and welded together. As soon as the process of casting iron was developed, shell were made by casting.

Metal-tube fuzes were devised in 1588 and were driven into metal shell. Lengths were designed to give the shell the ranges desired before bursting (from 1,000 to 2,000 yards). About 1750, wooden-tube fuzes, which could be cut off to lengths corresponding to the range desired, were developed. This was the first attempt to accurately time the bursts at the guns by the gun crew. So efficient did they become, that a few years later they were exploding shell over the heads of foot troops. These reed, wooden, and flexible-tube fuzes were used until after the Civil War in this country when string fuzes made their appearance. These were attached to the shell at the arsenal and cut to length in the field.

Detonating primers, using the already-known fulminate of mercury, came to notice in 1800, but it was not until 1846 that they were combined with a powder train in disk-type fuzes to make percussion time fuzes. This type is still in use today on certain high-explosive shell. This fuze contains a metal cylinder with space for a short movement within the fuze body. When the shell is fired, this cylinder, which has previously been kept in position by a spring, is snapped back by inertia, thus detonating a primer. The primer fires a powder train the length of which can be regulated to meet the range desired. From this it was only a step to the percussion fuze in which the hammer remains to the rear of the fuze cavity until the shell strikes, when it is thrown forward against a primer which instantly detonates.

Modern high-explosive shell contain a bursting charge which is exploded by means of a fuze either on impact or by powder train at some predetermined point in its trajectory. The first type is known as a percussion or impact fuze and the second as a time fuze. The fuze may contain both elements and is then known as a combination fuze. Fuzes may be located either in the nose or base of a shell and are further classified as supersensitive, superquick, and delay. The supersensitive fuze will explode at the touch of a light object. It is designed to detonate even when it strikes the wing or fuselage of a light airplane. Superquick fuzes function immediately upon impact and are used against foot soldiers, light material targets, barbed wire, etc., and with chemical shell. On the other hand, delay fuzes of varying time increments are designed to permit the shell to penetrate before bursting. Large craters are formed by these shells when ground penetration is achieved. Buildings, fortifications, etc., are demolished. Some armor-piercing shell used against tanks are equipped with them. They are also sometimes employed to allow a ricochet to effect a burst directly above troops. Mechanical time fuzes using clock springs, escapements, etc., are military secrets of a high order and they will not be discussed here.

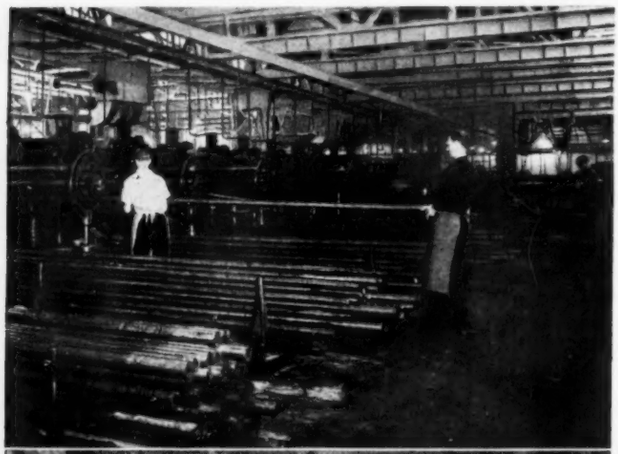


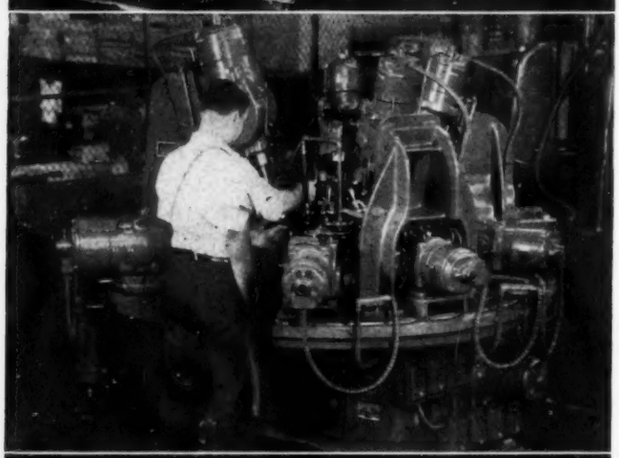
Hayes' "Elements of Ordnance"

SECTION OF A 37-MM. SUPERSENSITIVE FUZE

AN EFFECTIVE 37-mm. high-explosive antiaircraft supersensitive fuze was first made with the head of the firing pin in the shape of a cap that formed the tip of the nose. When in flight, the pressure of the air against this cap would have forced the pin back against the primer hard enough to detonate it had not vents been drilled in it. These let the air into the cavity containing the firing pin, and, while the air inside was practically static, it exerted the same pressure against the inner surface of the head as did the dynamic flow of air against the outside. On contact with an object, such as airplane fabric, the perforations were closed, thereby stopping the static pressure and permitting supersensitive detonation. This construction has now been changed; today the firing-pin head is only slightly larger than the pin shank and sets below the rim of the nose of the fuze, sealed in by a disk that is air-tight. The rim of the nose is so thin that

*Industrial Service, Office of the Chief of Ordnance, Washington, D. C.





it collapses on contact with airplane fabric allowing the contact to push the pin into the primer.

The 37-mm. high-explosive supersensitive shell fuze is one of the simplest of fuzes, both in number of parts and method of manufacture—it is made up of only fourteen different pieces. The main parts—the body, head, and nose, all of aluminum—screw together to form the fuze. The nose contains the aluminum plunger or firing pin. In the head is located the primer and a safety device to keep the firing pin from hitting the primer prematurely. The body holds two detonator charges, as part of the explosive train, with a flashhole between and a brass safety device, known as a slider, crossing the flashhole.

In the nose there are, in addition to the firing pin, two other parts—a closing washer of brass and a diaphragm or disk of aluminum which close the open end of the nose and prevent the firing pin from falling out. The safety device is the old Semple design of brass half blocks and springs, simplified. Instead of two spiral springs the blocks are now held together by a circular band spring of beryllium copper. The

←—Massive, electrically driven automatic machines, furnaces to melt aluminum scrap, and women's skilled fingers are all elements of fuze production.

half blocks are centered by the point of the firing pin which rests in a hole in the center of the two. A shoulder on the firing pin rests against the blocks, and it can go no further until the shell is fired. The centrifugal force of rotation, being stronger than the spring, throws the blocks out, leaving the firing pin free to pierce the primer when the nose of the shell hits some object.

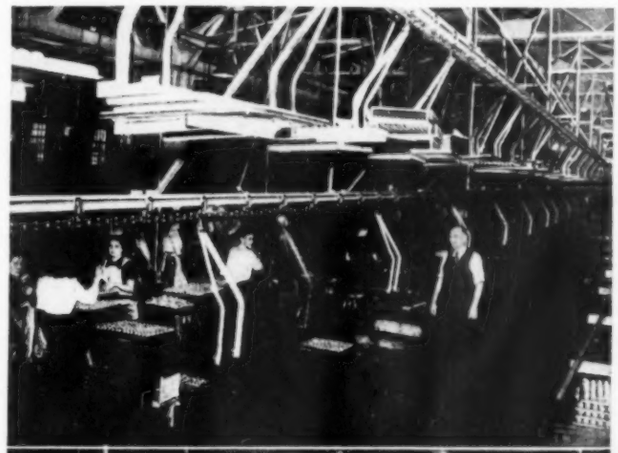
Between the primer and first detonating charge is a booster charge which is held in a brass cup which screws into the bottom of the head. Of course, holes are provided for the continuity of ignition throughout the explosive train. This passage is interrupted by the brass slider, previously mentioned, until the shell is fired. When projected from the gun, centrifugal force again comes into play, forcing the slider, a brass post with a hole through one end, outward against a restraining spiral spring. This movement brings the slider hole in line with the flashhole between the two detonating charges. Thereupon, the shell is fully armed; that is, the firing pin is free to strike and the explosive train has an uninterrupted travel from one component to the other. A detonator holder, a shallow aluminum cup, screws onto the bottom of the fuze body.

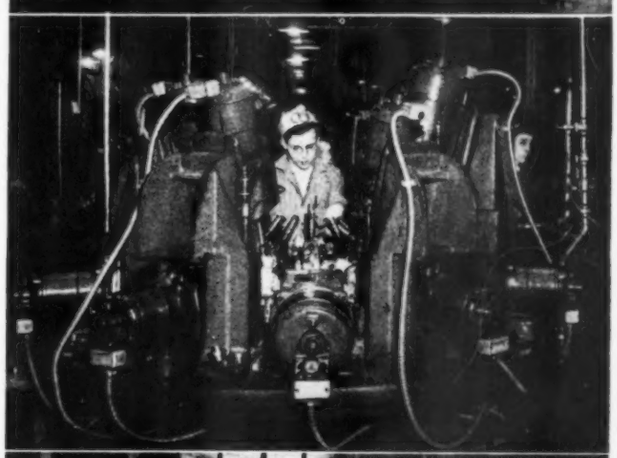
Manufacture offers no difficulties providing the proper machines are available; those most frequently used are automatic screw machines. The body, head, and nose are made on these, using bar stock. The body, for instance, is made on a Gridley automatic screw machine with six spindles. The bar stock is 1⅛ inches in diameter. Here the rear end is counterbored, tapped, and threaded, the flashhole bored, and the whole profiled and then cut off. It is then put in either a Brown & Sharpe or Kingsbury automatic screw machine with four stations where the other end is counterbored and tapped. A New Britain automatic chucking machine is now employed to drill, counterbore, and tap the slider hole. This hole is successively smaller with three diameters, the smaller inner hole being eccentric to the two outer larger holes. A wrench hole and a staking notch are

drilled and milled respectively and the body is finished by burring and cleaning.

The head is made in two No. 2 Brown & Sharpe automatic screw machines. The first of these forms, drills, reams, and taps the front end, while the second drills, reams, taps, threads, and cuts a recess in the rear end. Notching is done by a special milling machine and burring finishes the part. A Davenport automatic screw machine is used to make the nose which it drills, reams, forms, recesses, and threads. It is finished in a Sundstrand milling machine which mills a slot guide for the half blocks. It is then burred.

The slider is rod-shaped with a head to which it is eccentric. This is to keep it so located in the fuze body that the axis of the flashhole will always be in alignment with the axis of the fuze-body flashhole. It is made in a Davenport automatic screw machine with a special attachment for hollow milling the eccentric portion. The flashhole is put through in a drill press with a Govro Nelson set-up. Either a Davenport or a No. 00 Brown & Sharpe is used in making the firing pin, the first operation forming the point and the





Modern equipment and highly trained workers insure speed with accuracy, so essential in the mass production of fuzes for the Army's artillery shells.

second forming the head. The latter type of machine is also employed in making the half blocks, which are simply grooved and cut to length. The stock is extruded brass rod and two lengths are soldered together before feeding to the machine.

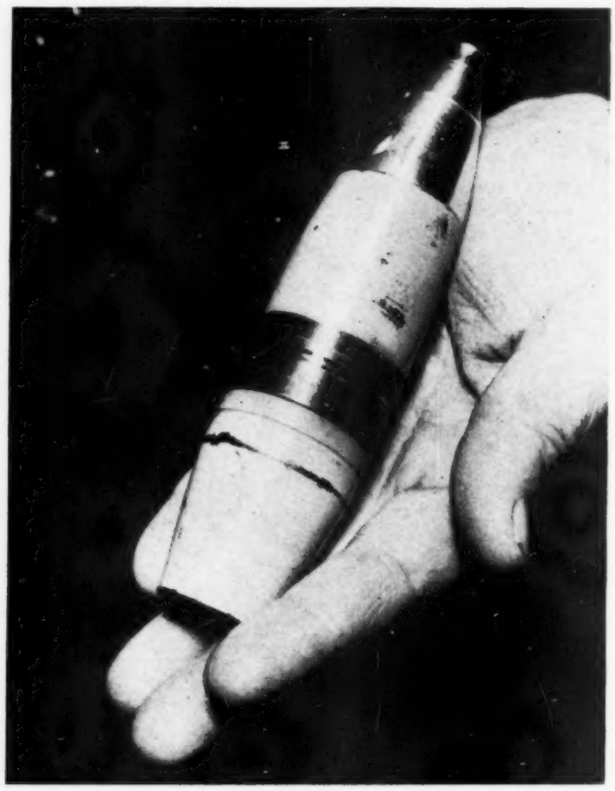
The brass retaining cap for the slider is also turned out in an automatic screw machine while the nose diaphragm and closing washer are stamped out in presses. Every part is inspected by the factory and is rechecked by the Government. Electric, dial, and hand gages are used, and girls are mostly employed for this inspection.

Fuzes also are assembled by girls at long lines of well-lighted tables. Parts are placed before the girls in wooden racks, and when the firing pin and half blocks have been put in and the head and nose screwed together the washer and diaphragm are spun into the end. The fuze is then whirled in two machines for testing the half-block spring. This spring should not open at 10,000 r.p.m. but must release the blocks at 32,000 r.p.m. The nose, body, and slider assembly are shipped knocked down to a loading plant where the explosive charges are put in and the fuze assembly completed.

AN IMPORTANT fuze for the 75-mm. shell is a combination superquick and delay fuze that can be set for either action by the gunner. It includes several subassemblies with a total of thirty-four separate parts. The body contains all the subassemblies except the head which is screwed onto the firing tube which in turn is screwed onto the body. The ogive or streamlined portion is held between the head and the body. The head contains the superquick firing pin and the primer or detonator which flashes down the firing tube into the booster charge located between the fuze and the shell explosive charge.

The delay portion consists of the delay firing-pin assembly and a plunger-body assembly that fit and operate together within the fuze body. The first is a ring with the

firing pin screwed into the edge. The second is a brass plug with several cavities, one of which holds two detonators. These two assemblies have a play of about a quarter of an inch but are held apart by a spiral spring. When the shell strikes, the weight of the plunger body throws it forward, striking the first detonator against the delay firing pin. Two detonators, one igniting the other, delay the ignition of the booster and explosive charges long enough to allow penetration of the shell.

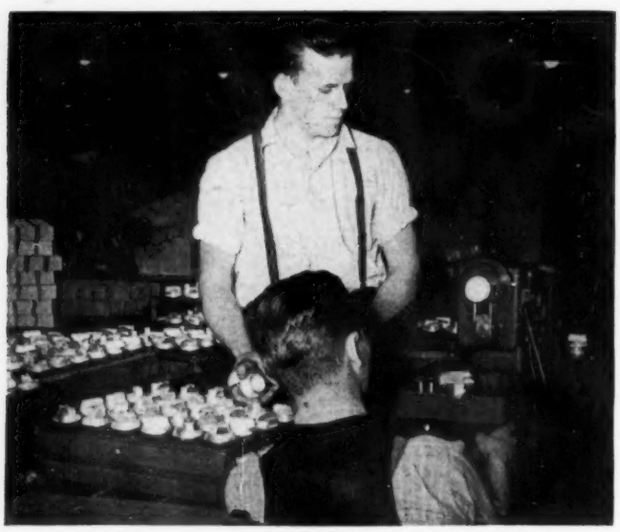


Comparative Size of a 37-mm. Projectile

Two safety devices are included, both of which operate by means of centrifugal force. The first is a short brass rod, known as an interrupter, which operates in a hole in the fuze body and across the firing tube, closing this tube so that no flash can pass. This rod is held in place by a restraining spring. This throws out and clears the firing tube when the shell is fired and rotated by the rifling of the gun. Two similar rods in the plunger body, known as centrifugal pins, rest against the end of a hollow post, the extension of the firing tube, and thus lock the delay firing-pin assembly and plunger-body assembly apart. Rotation on firing throws these pins out against their springs, leaving the two assemblies free to operate, thus arming the shell for detonation.

This type machine, and others, have been designed or tooled at the request of the Ordnance Department for use in fuze making. In operation, it centers, forms the outside, cuts an outside thread, forms the inside, cuts an inside thread, and cuts off. Both sides of the body are then milled off to form a tongue on the top in a Kearney & Trecker miller while the side and top holes are drilled, reamed, and tapped in a 13-spindle Kingsbury drilling machine. Two half-round slots are cut on the large diameter in a Lapointe vertical broaching machine, the sharp corners left by the milling and broaching operations are removed on a polishing lathe, and the holes are smoothed in a motor burrer. Lettering is put on in a punch press and the whole is cadmium-plated.

The head is made from 1¼-inch brass stock in a 6-spindle Gridley automatic which forms the outside, drills a 2-step hole, reams and taps the threads in both holes in the rear end of the head. This piece is then chucked in a No. 2 Brown & Sharpe where a hole is drilled and formed in the front end. A wrench and a staking hole are drilled in a Govro Nelson and the whole is burred on a buffing wheel. Within this head are the firing pin and firing-pin support. The latter is a short thin-walled tube that holds the firing pin away from the detonator. This tube collapses when the shell strikes, allowing the pin to penetrate the detonator thus exploding the shell—and another fuze has accomplished its mission!



Inspecting and Testing Fuze Components

Dextrous Fingers Check Delicate Parts

Most of the parts are turned out on automatic-screw machines of various makes. By far the largest part is the body, and it is turned out of steel bar stock 2 9/16 inches in diameter in a Gridley automatic screw machine with six stations.

MAJ. GEN. JAMES H. BURNS

Appointed Chief of Ordnance of the United States Army to succeed Maj. Gen. C. M. Wesson, whose 4-year term will expire June 2, 1942.

Ordnance in the Field

Maintenance and Supply in the IV Army Corps during Maneuvers

Lieut. Col. L. Monroe Bricker*

THE IV Army Corps was in the field more than any similar unit of the United States Army during 1941, having participated in both the Louisiana and Carolina maneuvers during August, September, and November. Although the IV Army Corps was assigned to the Third Army, for the greater part of the time during the exercises in Louisiana it operated almost independently. It first conducted corps problems with units of the corps being opposed. They were followed by field exercises in which this corps was pitted against the other two corps of the Third Army.

It was only during the last two weeks of September that the IV Army Corps operated as part of an army when GHQ directed the maneuvers of the Second Army against the Third Army. These exercises afforded an opportunity for all Ordnance units of the corps to gain invaluable practical experience and provided an excellent proving ground to test Ordnance service.

The first attempt to organize Ordnance service in the field for the IV Army Corps was the result of a directive from the Third Army dated February 24, 1941, which authorized the formation of a provisional Ordnance battalion for the Louisiana maneuver with the Ordnance companies from the two National Guard divisions at Camp Blanding. These were the 106th and 118th Ordnance Companies (Medium Maintenance). The 28th Ordnance Company (MM) from Fort Oglethorpe was added to this provisional organization upon arrival in the vicinity of Pollock, La., about August 1, 1941.

The newly activated headquarters of the 4th Ordnance Battalion (Maintenance) came from Aberdeen Proving Ground and joined about August 15, 1941. It consisted of four officers and twelve enlisted men. The commander of an ammunition company was transferred to the corps headquarters to be the ammunition officer. An administrative section was organized under a technical sergeant. It will be remembered that the Ordnance section of the corps headquarters and the battalion headquarters are consolidated in the tables of organization, with the corps Ordnance officer serving as the battalion commander. The corps Ordnance service was then organized as indicated in the chart on page 969.

THE two months in Louisiana afforded a period for organization and shakedown, and when the time came to prepare for the "war" in the Carolinas it was felt that it was a veteran organization. However, the scope of our mission to provide Ordnance service in Carolina took on much larger proportions for, during the entire period, the corps was to function independently of an army, directly under GHQ, and, in addition to its normal components, most of the mechanized units were attached. The major units comprising the IV Army Corps which had to be furnished Ordnance service were: two Infantry square divisions; one Infantry provisional triangular motorized division; two armored divisions; one Field Artillery brigade consisting of two regiments of 155-mm. howitzers, one regiment of 155-mm. guns, and one antitank battalion; one antiaircraft brigade consisting of three antiaircraft regiments and one antiaircraft battalion; two Engineer regiments; one Engineer battalion; one regimental combat team; one Infantry regiment; one Cavalry regiment (horse); two Cavalry regiments (horse-mechanized).

The 4th Ordnance Battalion (M) directly handled the maintenance of all organizations within the corps except for the armored divisions, which had their organic Ordnance maintenance battalion, and the provisional motorized triangular division, which had a medium-maintenance company attached as an organic unit. The battalion reënforced the units handling these two organizations in a manner similar to an army battalion.

The 57th and 65th Ordnance Companies (AM), although army units, were left with the IV Army Corps. During the Carolina maneuvers, the 64th Ordnance Company also was attached, giving the corps three colored ammunition companies. All three companies were attached to the 4th Ordnance Battalion for administration and supply but functioned directly under the corps ammunition officer. These companies handled the ammunition supply for the entire corps, including the armored units. The depot for ordnance supplies was operated by about 75 men and 3 officers from the 84th Ordnance Company and 10 men and 1 officer from the 73rd Ordnance Company. These units were not attached to the battalion as they were usually too far to the rear and were not moved as frequently. Altogether there were approximately 2,045 enlisted men and about 125 officers in all Ordnance units supplying Ordnance service to about 104,000 combatant troops, or a ratio of about 1 to 50.

FOR the Carolina maneuvers, the Chief of Ordnance temporarily attached a captain to the IV Army Corps as assistant to the corps Ordnance officer. This left the ammunition officer free to handle ammunition exclusively. The need for a regularly assigned assistant corps Ordnance officer is very real. The duties of the corps Ordnance officer as a member of the special staff of the corps commanding general often occupied so much of his time as to make it physically impossible for him to maintain the necessary contact with all the Ordnance units within the corps. In these instances, as well as in a great number of routine duties, the assistant was able to carry on for him, thus eliminating delays which otherwise might have occurred and thereby generally improving the efficiency of the Ordnance service.

This section is the immediate contact with the corps general staff and coördinates and controls all Ordnance service within the corps. Through it, essential advance information, as well as actual orders of the general staff, are transmitted to all Ordnance units in advance of the normal routine channels of distribution. By means of telephone communication and frequent liaison, this section directed all tactical moves of the battalion as well as the moves and establishment of all the ammunition supply points. The section was,

*Corps Ordnance Officer, IV Army Corps. Lieutenant Colonel, Ordnance Department, U. S. Army.

in other words, the "GHQ" of the corps Ordnance service.

It is well known that there are several schools of thought as to the manner in which Ordnance service should be organized and administered. The writer has made every effort to keep an open mind on the subject and to keep nonessential factors out of its analysis. After a careful study of the problem through three months of intensive field maneuvers, I am completely convinced that the battalion organization is the most effective and practical way of administering and directing Ordnance activities within the corps.

Probably the strongest argument in favor of the battalion is the great advantage gained by having a parent organization which knows and understands the problems of the Ordnance company and whose interests are not otherwise divided. The battalion headquarters, with a better knowledge of all factors involved, in one operation does many things that otherwise would have to be planned and done by each separate unit, thereby effecting a great saving of man-hours and vehicles.

Some examples of this are the reconnaissance and selection of bivouac areas, securing of routings, consolidation of requirements, drawing of rations and other supplies, collection and delivery of mail, handling of personnel records, and administrative matters including courts-martial. All these and many other essential routine functions are headed up in one sympathetic parent organization. It forms a bond of Ordnance units for which there is no substitute or equal. It makes a family of a group of orphans. A battalion of this type dependably disseminates vital information, obtains and executes orders direct, and is responsible to no one but the corps commander.

A distinct advantage is the fact that the battalion is commanded by the corps Ordnance officer. This provides a close working arrangement between all Ordnance units and with the corps general staff, thus greatly increasing the efficiency of the Ordnance service. Several other corps special-staff officers have expressed to me their high respect for this Ordnance arrangement as well as a wish that they too commanded their own corps units. General-staff officers likewise have expressed their satisfaction at being able to deal with only one headquarters and still know that all Ordnance units within the corps would receive the information and comply through that headquarters.

CONTRARY to the opinion of some, the organization of maintenance companies into a battalion does not mean that they must always be closely grouped, nor does it prohibit the sending of a single company or separate detachments to places convenient to combat forces at some distance. A number of detachments, ranging in size from a few men in one vehicle to a whole medium or heavy company with its full complement of men and equipment, were sent out on such details. The much greater latitude in selecting and organizing such detachments and in providing them with the necessary tools, equipment, and replacement parts, without seriously impairing the efficiency of the rest of the organization, is another strong argument in favor of the battalion formation. If a single company, functioning independently, were called upon to send out a detachment of any size, it would be definitely crippled and might well be rendered incapable of satisfactorily handling the very next job which came to it from the combat troops.

The advantages gained by having a battalion headquarters supply section control and expedite the securing of all classes of supply, especially replacement parts, cannot be overemphasized. Single Ordnance companies, dependent on some outside and not-too-sympathetic organization, often encounter many difficulties in obtaining necessary supplies—a situation that can be eliminated or reduced by a parent organization such as the battalion.

Preceding any movement of the battalion, an advance party selected and designated the locations for bivouac and shop areas of all units. Central and convenient locations near converging main arteries of traffic, adequate cover for concealment, suitable drainage, and a traffic loop through camp and shop areas were essentials.

An officer from each company either accompanied the advance party or preceded the movement of his organization in order to place guides and markers and lay out the camp. The battalion advance party also looked into such matters as location of gasoline and ration depots, corps headquarters, message center, and water points, thus freeing the companies of these housekeeping duties and eliminating unnecessary duplication.

Bivouacs were laid out so as to separate shop areas, to provide protection against air raids, and to keep kitchens close to the road. Each shop vehicle was assigned a concealed parking space, identified by small signs, to which it returned after any mission. Road signs indicating the route to the battalion area were erected at all principal road junctions for a number of miles to the front. Location of the battalion also was published in the administrative orders and accompanying overlay published by G4.

A tent shop office, identified by a prominent sign, "Stop here for work orders," always was erected at the entrance to the shop areas. Here all work was received and a shop order written. This was the battalion maintenance officer's headquarters, and through it he regulated and controlled the flow of work to the various companies.

Originally all combat units were assigned for maintenance to a definite company. This assignment was based roughly on the number of weapons and amount of equipment in the combat units so that the load on the companies was equalized, and as work entered the shops it was routed to the assigned company. This plan was generally followed, but occasionally it was found necessary to use the regulating-station theory to distribute the load evenly among all companies. The battalion maintenance officer, knowing the amount of work in each shop as well as the special capabilities of each company, assigned each job as it came in to a specific company on a shop order.

AT THE outset, it must be understood that maneuver maintenance problems are largely of a different nature than will be encountered during actual warfare. Weapons without ammunition or with blank ammunition are just so much burdensome impedimenta to the tired soldier, while tanks, half-tracks, and scout cars are wonderful, new, high-powered toys from which he endeavors to get the maximum performance with more thought for the thrill than the care of the vehicle. Too often his enthusiasm and the weight of his foot overcome his good judgment with disastrous effects.

As a result, overturned vehicles and damage from collisions occasioned the major portion of automotive and artillery maintenance, with preponderant emphasis on the automotive. Small-arms maintenance was limited almost entirely to lost and damaged parts which was not the result of firing or being fired upon. In the absence of actual shooting, opti-

cal instruments were scarcely used and hardly any instrument-repair work was brought in. Except for necessary evacuation of damaged vehicles, the work of the maintenance companies during tactical problems was extremely light. The using troops were concerned only with the successful prosecution of the problem, and necessary repairs and maintenance were given second priority until the end of the problem when the work would literally stream into the shops.

During actual combat this situation will be different. Then Mr. Soldier, realizing that his life depends upon it, will polish his rifle and nurse his vehicle. Casualties will result more from gunfire than from carelessness, although there still will be a certain proportion due to overturning and collisions. There will be no recesses between problems occurring regularly every four or five days, so the troops may be expected to use every opportunity to get needed repairs, and the flow of work through the shops may be comparatively more even and steady.

During the Louisiana maneuvers, corresponding sections of all companies were grouped together under the senior section officer, for it seemed theoretically desirable to operate one automotive or artillery shop in preference to several. No attempt was made to mix tools or personnel of the different companies. Minor frictions developed between different groups, and it seemed a little more difficult for the respective company commanders to keep abreast of the work of their unit. During the Carolina maneuvers, the companies were grouped, each operating their own sections, and a better feeling seemed to exist. However, the difference is small, and it is believed that under actual combat conditions the consolidated-shop system is to be preferred.

UNLESS corresponding sections are grouped, the increased efficiency gained by being able to combine the tool, parts, and personnel resources of all companies is lost. For instance, if a job requires the use of four jacks and the company doing it has only two, it is a great advantage to have a corresponding section handy where these tools can be borrowed. When weighing this thought, consideration must be given to the distances between trucks, sections, and companies which are necessary for proper safety gained by dispersion. Forty yards between vehicles was the distance prescribed by the corps commander. Eight to ten acres are required to properly disperse a battalion of three medium-maintenance companies.

No attempt was made to pool or group the supply sections of the companies; as long as property accountability is maintained, it is believed that these should be kept entirely separate. It is especially important that all companies maintain a complete stock of parts for all classes of matériel they may be called upon to service. Groups should not be distributed among the companies nor is it advisable to divide the supply section of a company among its various shop sections any more than is required by the construction of the vehicles. For instance, the small-arms and optical-repair trucks are equipped to carry many parts, but beyond that it seems highly desirable in the interests of efficiency to keep the company supply section intact.

During both maneuvers, the supply of required replacement parts, many of them common parts, was extremely uncertain and unnecessarily slow. Except for the practice of robbing other deadlined equipment to get necessary parts, many of the jobs never could have been completed. It is to be hoped that every effort will be made to establish sufficient stocks of replacement parts within reasonable reach of the maintenance units.

Two corps maintenance parties operated from each company daily and visited units assigned to their company. This system is highly recommended for it builds an acquaintance between personnel and a familiarity with equipment being maintained which is most desirable. Lack of complete maintenance equipment was a handicap.

Maintenance trucks were clearly marked and directed to stop any place where assistance was required. The governing policy was to make it just as easy as possible for all troops to obtain maintenance and to provide the impetus for maintenance from the rear. The corps Ordnance plan contained the following paragraph:

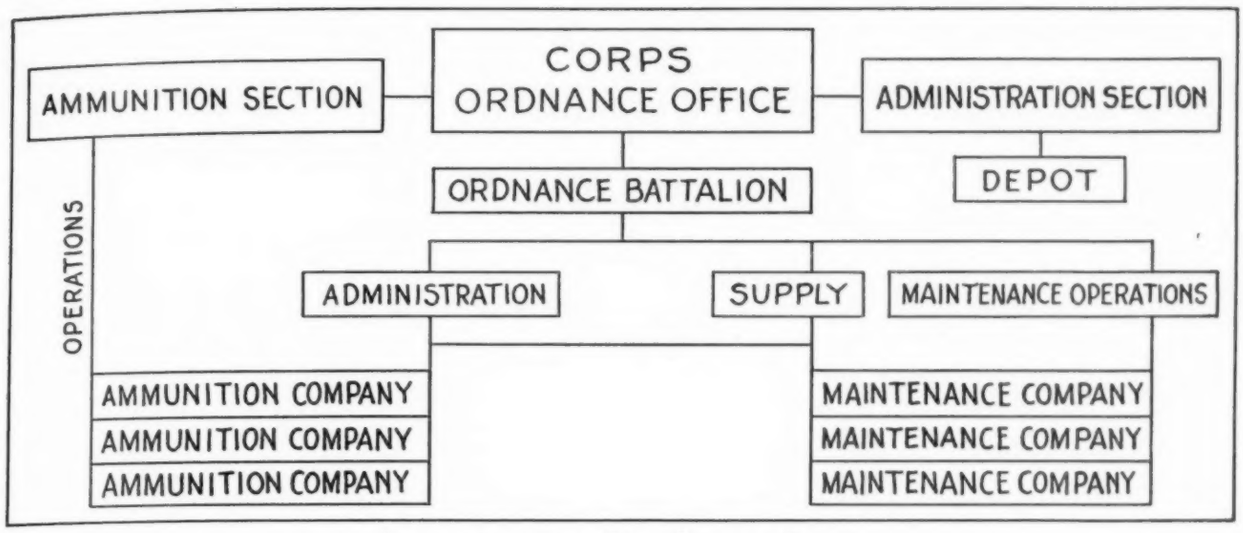
"The division ammunition office will be the normal place of contact between division contact parties and corps maintenance parties. At this point, corps maintenance parties will be informed of requirements and directed to the place requiring service. Any unit may place requests for Ordnance service with any contact party, at any ammunition office, with any maintenance company, at Ordnance battalion headquarters, or with the corps Ordnance section. Requests for work should be made in writing and be authenticated by a unit officer on a standard form."

The establishment of the division ammunition office as the normal place of contact between the division contact parties and the corps maintenance parties was a most practical solution to the serious problem of locating troops whose position was changing daily. Close coöperation between the parties at this point eliminated much time and travel which would have been necessary to find the organizations being serviced. The use of a liaison officer or enlisted man with the forward units was also a great help in this respect.

During both problems of the GHQ phase, mechanized cavalry regiments were operating on both flanks at quite some distance from the battalion. In order to give them close-up maintenance, two detachments of twenty men and one officer each, with trucks, tools, and equipment, were attached to these flank units. These detachments performed some very valuable work when and where it was most required. Daily liaison with the battalion was maintained by messenger truck which also carried replacement parts from the battalion. This experiment was highly successful and proved the practicability of assigning small maintenance units to forces operating at a considerable distance.

INASMUCH as the experimental motorized division on these maneuvers had about 600 Ordnance vehicles, the War Department attached the 37th Ordnance Company (MM) to it for the maneuver period with no other assignment than the maintenance of the Ordnance equipment within that particular division. The company was reënforced by a detachment of one officer and eight men from the heavy-maintenance company. These men were well experienced in the maintenance of half-tracks and as leaders were of great help to this company on its first field assignment. The officer also acted as liaison with the 4th Ordnance Battalion.

The company selected was one of the last group activated at the Unit Training Center at Aberdeen Proving Ground, and, in the words of the commanding general of the division, "throughout the maneuver period (it) performed all assigned duties in an outstanding manner, proving of great value to the division, particularly on marches and where



ORGANIZATION OF THE CORPS ORDNANCE SERVICE

vehicle maintenance constituted a major problem." This company moved only on division order and bivouacked near the rear echelon of division headquarters. From this point it sent out daily four maintenance parties of four to seven men each, one to each of the four groups into which the division was divided. The company's work was fairly constant and heavy throughout maneuvers. While a medium-maintenance company proved to be very satisfactory as a temporary expedient, it is definitely not the final answer to the maintenance problem of a division of this type. A much larger company with more equipment is needed, and if the division is expanded to three combat teams plus a tank battalion, there will be over 1,200 Ordnance vehicles to be maintained, in which event a battalion similar to that used by the armored division may be necessary.

The Ordnance battalions with the I Armored Corps traveled with the armored divisions and under their orders, taking care of everything they could handle but evacuating or leaving the bigger jobs for the heavy-maintenance company and the corps battalion. During the first GHQ problem, the heavy-maintenance company was detached and assigned to the I Armored Corps. It was noted with interest that the bivouac locations selected for this company were never more than a few miles removed from the battalion. In one instance, the battalion was closer to the front than the heavy-maintenance company, and at any time all companies might well have been together.

During this problem, the heavy-maintenance company had more work from the armored divisions than it could conveniently handle, while the 4th Ordnance Battalion had some work in connection with the 155-mm. gun regiment which it was not prepared to handle because of the shortage of heavy wrecker equipment. Moreover, the demands on the battalion at this stage were comparatively light, and numerous men in the medium-maintenance companies were frequently idle. If the heavy-maintenance company had been with the battalion during this period it could have been reënforced with this surplus man power, the work load would have been equalized and more efficient Ordnance service provided.

In the triangular division, the division ammunition office manned by one officer and two clerks was set up near the command post of the division, while the division Ordnance officer with three clerks coördinated the Ordnance service within the division from the forward echelon. The ammunition officer was furnished with a radio car on the G4 net and the third officer in the section was attached to the division G4 as liaison. The remainder of the section was attached to the medium-maintenance company which then furnished the four maintenance parties mentioned in the foregoing discussion of this company. These four parties worked in close coöperation with the Quartermaster maintenance which also operated four parties and furnished wreckers, so that the maintenance parties for each of the four groups of the division had a wrecker available for use at all times. The section itself operated no contact parties.

THE square division sections were augmented by one officer and additional enlisted men from each of their respective maintenance companies to give the sections a personnel strength of three officers and twenty-two enlisted men each. These sections operated somewhat differently than those of the triangular division. The division Ordnance officer was in the forward echelon, and the section moved with the forward echelon but operated out of the division ammunition office which was usually somewhat in rear of the forward echelon. Each division operated two contact parties checking on the first-echelon maintenance, doing as much additional work as possible, and serving as liaison between the combat troops and corps maintenance parties. The ammunition control was handled in a manner similar to that in the triangular division.

As a whole, the experiences of the maneuvers were extremely valuable, and the operation of the corps Ordnance service was highly successful. During the entire period, heavy and exacting demands were made upon Ordnance personnel, and in every case they responded with pride and enthusiasm.

In the beginning, some misgivings were felt about the capabilities of many of our men, as all units had been either newly activated or recently reorganized and expanded. These fears soon were dispelled and replaced by confidence. It was clearly demonstrated that the efforts of the Ordnance School and the application of the mobilization training program were absolutely sound, and the men were quickly amalgamated into efficient groups which were thoroughly capable of handling every situation which arose.

ARMY ORDNANCE

Founded 1920

Published Bimonthly by
THE ARMY ORDNANCE ASSOCIATION
WASHINGTON, D. C.

Col. J. L. Walsh, Founder and Editor, 1920-1922
Brig. Gen. R. H. Somers, Editor, 1922-1925
Maj. Gen. R. L. Maxwell, Editor, 1925-1926
Col. C. R. Baxter, Editor, 1926-1929

Editor: Lieut. Col. L. A. Codd, Ord. Res.
Associate Editor: R. E. Lewis, Jr.
Editorial Staff: F. G. Ferriter, H. E. Allen, O. T. Wingo, F. W. F. Gleason, N. A. Woodhouse, M. E. Ferriter, J. C. Dunbar.

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MAY-JUNE, 1942

Month by Month

MAJ. GEN. JAMES H. BURNS, an Ordnance leader of outstanding attainments, will become Chief of Ordnance of the United States Army, June 2, 1942, upon the expiration of the 4-year term of office of Maj. Gen. Charles M. Wesson. No one of the fifteen chiefs of Ordnance who have preceded him has embarked upon this important assignment in the midst of a war effort as great and as difficult as that which confronts General Burns. But he brings to the task genuine ability and broad experience. As General Wesson relinquishes the command with highest honors for his historic achievement, so General Burns assumes it with every augury for success during the difficult years that lie ahead.

ARMY ORDNANCE bespeaks to the new Chief—and in this regard it is the voice of the more than 11,000 members of the Army Ordnance Association—a confidence born of long years of observation. It reaffirms the willingness and desire of this nation-wide Ordnance fraternity to assist him at all times in the trials and demands of this war and its aftermath. To the retiring Chief of Ordnance, speaking for the same group, this journal writes "Well done, General Wesson" in the greatest military armament endeavor the world has seen thus far.

General Burns assumes his new responsibilities with a professional background seldom equaled in our service. Born in Pawling, N. Y., he was graduated from the United States Military Academy on February 14, 1908, and began his Army service as a second lieutenant of Field Artillery. He served with the 1st Field Artillery at the Presidio of San Francisco, Calif., for two years, during which time he attended the School of Musketry at the Presidio of Monterey. He was detailed in the Ordnance Department, June 1910, serving during the next four years at the Sandy Hook Proving Ground and at the Picatinny Arsenal. Having returned to the Field Artillery, he saw service at Vera Cruz in 1914 and on the Mexican Border.

Again detailed to Ordnance, he returned to the Picatinny Arsenal to begin a period of technical work which soon placed him in the forefront of our military experts on powder and explosives. He remained at Picatinny until the beginning of the World War when he was ordered to Washington for duty in the Office of the Chief of Ordnance. In May 1918, he sailed for France to duty in the headquarters of the Chief Ordnance Officer, A.E.F. He resumed his service in the Office of the Chief of Ordnance in November of that year where he remained as chief of the Nitrate Division and later of the Ammunition Division until 1922. For his World War service he was awarded the Distinguished Service Medal with this citation:

"First as chief of the explosives branch, design section, gun division, in which capacity he was charged with the production of sufficient explosives, propellants, and shell loading for the needs of the American Government and her Allies; and later as chief of the explosives section, production division, with securing the necessary production of explosives, propellants, and assembly of ammunition to meet the needs of America in the World War."

In 1923, General Burns became ordnance officer, Ninth Corps Area, Presidio of San Francisco. He returned to Washington for duty in the Office of the Assistant Secretary of War and while on this tour of duty was graduated from the Army Industrial College. Following his graduation from the Army War College in June 1927, he commanded the Raritan Arsenal, Metuchen, N. J., for the next four years and again returned to Washington as chief of the Artillery Division, Office of the Chief of Ordnance. He became ordnance officer, Philippine Department, and commanding officer, Philippine Ordnance Depot at Manila, in 1932.

Upon his return to the United States in 1935 he was assigned to duty in the Office of the Chief of Staff and in the following year became executive officer to the Assistant Secretary of War. He recently returned from Russia where he served as a member of the mission to that country. At the time of his appointment as Chief of Ordnance, he was the senior assistant to E. R. Stettinius, chief of the Lend-Lease Administration. More recently he served as executive officer of the Munitions Assignment Board.

General Burns has all the qualifications of leadership: his thinking processes are direct, clear, and fearless; his manner is affable and impartial; his judgments are sound and objective. He embarks upon his new assignment fortified by a vast experience in the technology of ordnance, the technique of administration, and, more recently, in the higher councils of government. All these are necessary qualifications of his new office which he will not hesitate to apply at all times.

General Burns is a charter member of the Army Ordnance Association. He frequently has written for the pages of this journal. Indeed, in the very first issue he contributed a timely analytical article, "Commercial Possibilities of Government Nitrate Plants" (July-August 1920, Vol. I, No. 1, p. 15).

TO GENERAL WESSON, as he relinquishes his most exacting duties, his entire command will accord a full measure of admiration for a man who has performed a mammoth task with energy, devotion, and success. His term of office will expire officially June 2, 1942, and, inasmuch as he will reach the retirement age of 64 years on July 23rd, under a law which permits of no waiver, his administration of the great arms program which he began ends as that program comes to full flower.

When General Wesson assumed the duties of his office in June 1938, only the faintest rumblings of the coming world catastrophe were heard over the horizon. Scarcely had he undertaken his duties as Chief of Ordnance when congressional authority made possible the beginnings of an ordnance production program which were large by preceding comparisons but infinitesimal in the light of what was to follow. This program grew by leaps and bounds. But General Wesson had assisted for many years in planning for such an eventuality, and he was more than equal to the task when those plans had to be fulfilled. The energy and decision with which he met every step of that task have been recounted in successive issues of this journal. Appropriately enough, in the leading article in this issue he reviews in his own words—but with far too modest a treatment of the present status of his work—the record of Ordnance during his long connection with it.

This much can be said even in the close proximity of the present and without the perspective which only years will add: Ordnance of the United States Army from the start of General Wesson's leadership has met all major obligations—especially in tanks, artillery, helmets, and small arms. In design, development, procurement, production, supply, and maintenance functions, his leadership has inspired his vast organization to effort and achievement which are increasingly evident as American arms march on to victory.

In a more personal vein, the Army Ordnance Association gladly acknowledges its debt to one who has nurtured it from the beginning, assisted it through the years, and helped it at all times to produce its best work. General Wesson is a charter member of the Association, having been among that stalwart band who, in October 1919, formed this unique and, as time was to prove, valuable adjunct to our national defense and security. During the years when the annual fall meetings of the Army Ordnance Association at the Aberdeen Proving Ground were the rallying point for the small forces of industrial preparedness, it was the then Colonel Wesson, as commander at Aberdeen, who made available the facilities of that great institution and who directed the programs which were intended to show American engineering and industry the characteristics of weapons which would have to be made in quantity whenever war might come again.

In a day when public apathy to the very word "armament" was viciously rampant, it was the influence of General Wesson—the same forceful influence he had displayed on the playing field at West Point—that helped rally the forces of armament engineering and production to survive the attacks of pacifists who all but wrecked our meager arms-production facilities. More recently, despite the growing obligations of a constantly increasing arms program, he has brought to the members of our society a message of encouragement and of faith in the ability of America to design, produce, and supply weapons adequate in quantity and quality for any effort, no matter how great. His writings in these pages over many years give testimony of his zeal.

When General Wesson relinquishes his high command he can do so with a full realization that his efforts have been productive of phenomenal results for the defense of his country, that his far-flung organization numbering thousands of officers and men and tens of thousands of civilians in arsenals, factories, and depots, is operating with an *esprit* that cannot fail its noble purpose. On all sides—military, civilian, engineering, and industrial—he has not only the respect but the admiration and affection of all. And in this, when victory shall have come, will be his greatest delight and the delight of all in military and civilian pursuits who served with him.

The days ahead will be trying ones for the men of Ordnance—upon them rests the responsibility of producing, supplying, and maintaining the fighting equipment for the defense of liberty. But with such leaders as General Wesson and General Burns, and with such a glorious tradition of past achievement, there can be no doubt that every obstacle will be overcome and that the Ordnance spirit of service will burn more brightly in the light of final victory.

THE CHIEFS OF ORDNANCE
UNITED STATES ARMY

COL. DECIUS WADSWORTH
February 8, 1815 - June 1, 1821

COL. GEORGE BOMFORD
May 30, 1832 - March 25, 1848

COL. GEORGE TALCOTT
March 25, 1848 - July 10, 1851

COL. H. K. CRAIG
July 10, 1851 - April 23, 1861

BRIG. GEN. J. W. RIPLEY
April 23, 1861 - September 15, 1863

BRIG. GEN. G. D. RAMSAY
September 15, 1863 - September 12, 1864

BRIG. GEN. A. B. DYER
September 12, 1864 - May 20, 1874

BRIG. GEN. STEPHEN V. BENÉT
June 23, 1874 - January 22, 1891

BRIG. GEN. DANIEL W. FLAGLER
January 23, 1891 - March 29, 1899

BRIG. GEN. A. R. BUFFINGTON
April 5, 1899 - November 22, 1901

MAJ. GEN. WILLIAM CROZIER
November 22, 1901 - July 15, 1918

MAJ. GEN. C. C. WILLIAMS
July 16, 1918 - April 1, 1930

MAJ. GEN. SAMUEL HOF
June 2, 1930 - June 2, 1934

MAJ. GEN. WILLIAM H. TSCHAPPAT
June 2, 1934 - June 3, 1938

MAJ. GEN. CHARLES M. WESSON
June 3, 1938 - June 2, 1942

MAJ. GEN. JAMES H. BURNS
June 2, 1942

Armament Research

An Editorial

ARMS production and maintenance—and yet more production of complete weapons and spare parts—is the prime goal of the Ordnance effort for victory. Nothing can be permitted to obstruct the road to all-out weapon production until the forces of Japan, Italy, and Germany have been brought to total defeat. But armament research must continue to go ahead relentlessly, and when new developments appear they must be eased into the production line. Our fighting men must have the best. In our striving to produce and supply we must not be unmindful of research.

The military armament of the United States is equal to that of any other nation and is superior to that of many. With each passing day come reports of the excellence of ordnance in the hands of our own troops and troops of the United Nations. In many cases, battle results have far exceeded the expectations of our design engineers. This satisfactory state of affairs is the result of a long struggle on the part of the Ordnance Department of the Army which constantly has fostered improvement in weapon design and progress in all the basic engineering techniques which underlie that vast field.

The situation on a broader national-defense front is especially praiseworthy due to the recent efforts of the Office of Scientific Research and Development under the direction of a famed scientist and administrator, Dr. Vannevar Bush, president of the Carnegie Institution. This emergency organization functions directly under the President as a part of his Office for Emergency Management. It coöperates with the National Defense Research Council and the National Inventors Council. The Inventors Council collects engineering ideas, and the National Defense Research Committee allots worthy ideas to industrial and university laboratories for test and further development. According to a recent announcement, 360 research projects are in operation, distributed among 51 universities and 53 industrial laboratories. Although the nature of these researches is confidential, Commissioner of Patents Conway P. Coe has said that feats already have been accomplished that will startle the world!

The Army Ordnance Department, coincidentally, has a splendid nation-wide organization of engineering design committees. Its S.A.E. Ordnance Automotive Advisory Committee has functioned for many years with eminent success. Through the N.D.R.C., researches of the Ordnance Department and of the other technical branches of the Army as a whole, no less than of the Navy, have been taken into the broader fields of pure scientific research. The combined results now are that many of the country's best scientific minds are at work on the engineering problems of national defense to a degree never before known in our history and with effects which only the progress of the current conflict can disclose. These endeavors are worthy of the highest praise, and ARMY ORDNANCE acclaims them as among the most important national advances for victory. Research underlies all our strength of arms.

Indeed, the success of current research projects, as well as the volume of scientific talent now at work for armament development, prompts the suggestion that the National Defense Research Council, once its immediate war-time objective has been fulfilled, be continued as a stimulant to constant scientific research and development for the betterment of all classes of American armament. In this regard, the National Advisory Committee for Aëronautics is an excellent guide. We propose, therefore, that the N.D.R.C. and its affiliated organizations eventually be consolidated into a National Advisory Committee for Arms and Armament to be constituted along the same general lines as the National Advisory Committee for Aëronautics.

Our defense services must use materials of all sorts, metals of every kind, powder and explosives of unusual power. Our fighting implements must possess technical qualities of the highest order to insure their tactical success. The use of diverse materials and the constant change in designs of weapons and other fighting equipment present constantly arising problems which demand the assistance, not alone of the best, but of the most diversified scientific research and engineering talent of the country. It is both fitting and desirable, it seems to us, that thought be given even at this early date to such a continuing body of scientific power to guarantee at all times that American weapons will utilize the best that science and research in all fields have to offer.

A NATIONAL Advisory Committee for Arms and Armament would bring together at one council table representatives of the Army and Navy, the National Academy of Sciences, the National Bureau of Standards, and the National Advisory Committee for Aëronautics, with a goodly representation of industry and production experts acquainted with the principles of armament science and skilled in armament engineering.

Such a body would coördinate at all times the scientific research needs of national defense—military, naval, and aëronautic. It would prevent duplication in the field of weapon research. It would direct, under unified control, fundamental research for the military and naval forces and advise those services and private industry as to the latest pertinent technical information.

This proposal for continuing scientific arms research is made in the firm belief that our armament strength for decades to come will be the sole support of our national security. No longer can the popular attitude toward weapons for our fighting forces be of the niggardly, inadequate order which has predominated throughout our history. Our weapons must not again be allowed to suffer the popular disregard of 1920-1940. Nor can a few military and civilian experts be expected to master the entire range of the deeper fields of the sciences and apply those developments to our weapons. The problem and its consequences are far too serious for that. Superiority of American arms and armament in the years to come must be supported by a continuing and aggressive scientific policy which will utilize the brain power of American science in every field, in every laboratory, and under all conditions. In this way can we be sure that our fighting men will be equipped at all times with the advantages which all the sciences can offer. Less than this may jeopardize not only the safety of our fighting forces but the security of our nation itself. From now on, all scientists must pursue their researches with more than a side glance at the art of modern war.

L. A. C.

THE ORDNANCE ENDOWMENT HONOR ROLL

THAT VICTORY may come to our armed forces speedily through the prompt production of military armament and its supply to our fighting men is the *immediate* aim of the Army Ordnance Association through its eleven thousand members and eighteen local chapters. That the lessons now being taught by American industry in arms production may bring us for all time a better realization of our armament needs as a guarantee of peace is the *long-range* purpose of the Association's Ordnance Endowment. The specific objects of the Endowment and the personnel of the Endowment Committee, under the chairmanship of Mr. T. M. Girdler, of Cleveland, Ohio, have been published in these pages in recent issues of this magazine. On this Honor Roll are listed the names of the companies which have contributed to the Endowment since its recent establishment. The Honor Roll will be revised from time to time. When the Endowment shall have reached its goal of $500,000, a bronze plaque containing the names of all contributors will be erected in the Association's national headquarters at Washington. Contributions of from $1,000 to $10,000 are welcomed by the Committee. The Endowment fund as of April 10, 1942, totals $184,000. It is administered by American Security and Trust Company of Washington, trustee.

THE ARMY ORDNANCE ASSOCIATION
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WASHINGTON, D. C.

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Allis-Chalmers Manufacturing Company	*Milwaukee, Wis.*
Aluminum Industries, Inc.	*Cincinnati, Ohio*
American Car and Foundry Company	*New York, N. Y.*
American Locomotive Company	*New York, N. Y.*
American Steel Foundries	*Chicago, Ill.*
Anderson Manufacturing Company, Albert & J. M.	*Boston, Mass.*
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Autocar Company	*Ardmore, Pa.*
Babcock & Wilcox Company	*New York, N. Y.*
Baldwin Locomotive Works	*Philadelphia, Pa.*
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Cleveland Tractor Company	*Cleveland, Ohio*
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Continental Motors Corporation	*Muskegon, Mich.*
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Copperweld Steel Company	*Glassport, Pa.*
Crane Company	*Chicago, Ill.*
Crocker-Wheeler Electric Manufacturing Company	*Ampere, N. J.*
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Diamond T Motor Car Company	*Chicago, Ill.*

Disston & Sons, Inc., Henry	*Philadelphia, Pa.*
Du Pont de Nemours & Company, E. I.	*Wilmington, Del.*
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Harnischfeger Corporation	*Milwaukee, Wis.*
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Mesta Machine Company	*Pittsburgh, Pa.*
Miller Printing Machinery Company	*Pittsburgh, Pa.*
Minneapolis-Honeywell Regulator Company	*Minneapolis, Minn.*
Minneapolis-Moline Power Implement Company	*Minneapolis, Minn.*
Motor Wheel Corporation	*Lansing, Mich.*
Mullins Manufacturing Corporation	*Salem, Ohio*
Murray Manufacturing Corporation	*Brooklyn, N. Y.*

THE ORDNANCE ENDOWMENT HONOR ROLL

(Continued)

National Supply Company	*Pittsburgh, Pa.*
New Haven Clock Company	*New Haven, Conn.*
Norton Company	*Worcester, Mass.*
Ohio Steel Foundry Company	*Lima, Ohio*
Pratt & Whitney Division, Niles-Bement-Pond Company	*West Hartford, Conn.*
RCA Manufacturing Company	*Camden, N. J.*
Republic Steel Corporation	*Cleveland, Ohio*
Reynolds Metals Company	*Richmond, Va.*
Salem Engineering Company	*Salem, Ohio*
Savage Arms Corporation	*Utica, N. Y.*
Sheffield Corporation	*Dayton, Ohio*
Smith Corporation, A. O.	*Milwaukee, Wis.*
Sowers Manufacturing Company	*Buffalo, N. Y.*
Sperry Gyroscope Company	*Brooklyn, N. Y.*
Stearns-Roger Manufacturing Company	*Denver, Colo.*
Stewart-Warner Corporation	*Chicago, Ill.*
Taylor-Wharton Iron & Steel Company	*High Bridge, N. J.*
Timken-Detroit Axle Company	*Detroit, Mich.*
Timken Roller Bearing Company	*Canton, Ohio*
Tokheim Oil Tank & Pump Company	*Fort Wayne, Ind.*
Tube Turns, Inc.	*Louisville, Ky.*
Union Carbide & Carbon Corporation	*New York, N. Y.*
United Engineering and Foundry Company	*Pittsburgh, Pa.*
United Shoe Machinery Corporation	*Boston, Mass.*
U. S. Automatic Corporation	*Amherst, Ohio*
U. S. Machine Corporation	*Lebanon, Ind.*
Vultee Aircraft, Inc.	*Vultee Field, Calif*
Warner & Swasey Company	*Cleveland, Ohio*
Warner Electric Brake Manufacturing Company	*Beloit, Wis.*
Waterbury Clock Company	*Waterbury, Conn.*
Wellman Engineering Company	*Cleveland, Ohio*
Western Cartridge Company	*East Alton, Ill.*
Wheeling Steel Corporation	*Wheeling, W. Va.*
White Motor Company	*Cleveland, Ohio*
Yellow Truck & Coach Manufacturing Company	*Pontiac, Mich.*
York Safe & Lock Company	*York, Pa.*

Compiled as of April 10, 1942

Association Affairs

NEW ASSOCIATION DIRECTORS

THE Board of Directors of the Army Ordnance Association announces the appointment to its membership of two charter members of the society: T. M. Girdler of Cleveland and Thomas A. Morgan of New York. Mr. Girdler succeeds as a member of the board Maj. Gen. C. C. Williams who resigned when he returned to active duty in the Office of the Chief of Ordnance. Mr. Morgan succeeds Lieut. Col. LeRoy Hodges who also resigned upon entering active military service, likewise in the Office of the Chief of Ordnance. The new appointees were announced at the annual meeting of the Board of Directors of the Association in New York City on February 17th.

T. M. GIRDLER

Tom Mercer Girdler, chairman of the Association's Committee on Endowment, was born on a farm in Indiana, May 19, 1877. He was educated in the schools of Louisville, Ky., and was graduated from Lehigh University with the degree of mechanical engineer in 1901. His first engineering position was as a civilian employee in the Ordnance Department at the Sandy Hook Proving Ground under the late Brig. Gen. John H. Rice. He began his commercial career with the Buffalo Forge Company with headquarters at London, England. A year later he joined the Oliver Iron & Steel Company of Pittsburgh where he remained until 1905. After two years in the service of the Colorado Iron & Fuel Company at Pueblo, Colo., he became general superintendent of the Atlantic Steel Company, Atlanta, Ga. He returned to Pittsburgh in 1914 to become assistant superintendent of the Aliquippa Works of the Jones & Laughlin Steel Corporation. From this position he rose to the presidency of the company.

When several independent steel companies in the Midwestern States were being consolidated into the Republic Steel Corporation in 1929, Mr. Girdler was called to aid in its organization. He has been chairman of the board of Republic Steel ever since. From 1930 to 1937 he also served as president.

In December 1941, when the Aviation Corporation, of which Mr. Girdler has long been a director, acquired through its subsidiary, Vultee Aircraft, Inc., a substantial ownership in the Consolidated Aircraft Corporation, Mr. Girdler became chairman of the board and chief executive officer of both Vultee and Consolidated, two of the largest producers of airplanes for the fighting forces of the United States.

He is a director of Goodyear Tire & Rubber Company of Akron, Ohio, and of the American Iron and Steel Institute. He is a trustee of Lehigh University and Case School of Science.

Thomas Alfred Morgan, a charter member of the Army Ordnance Association, was born in Vance County, N. C., September 27, 1887. He served as an electrical engineer in the United States Navy from 1908 to 1912 and on the engineering staff of the Sperry Gyroscope Company from 1912 to 1916. He served successively in important administrative positions with that company, becoming chairman of the board in 1932. He has also served as president of the Sperry Corporation since 1933.

Exponent of research and development in the application of electrical and mechanical enginering to marine, aviation, and transportation instruments, Mr. Morgan has been a strong factor in the growth and success of instrumentation in these fields. He is chairman of the board and director of Sperry Gyroscope Company, Vickers Incorporated, and Ford Instrument Company; director and chairman of the executive committee of Pan American Airways, Inc.; director of the Lehman Corporation, Sperry Securities Corporation, Commercial National Bank & Trust Company, National Foreign Trade Council, Inc., and American Arbitration Association; governor of the Aëronautical Chamber of Commerce of America; a member of the executive committee, Aëronautical Advisory Council, Department of Commerce; a member of the New York State Council of National Defense and of the American Society of Mechanical Engineers.

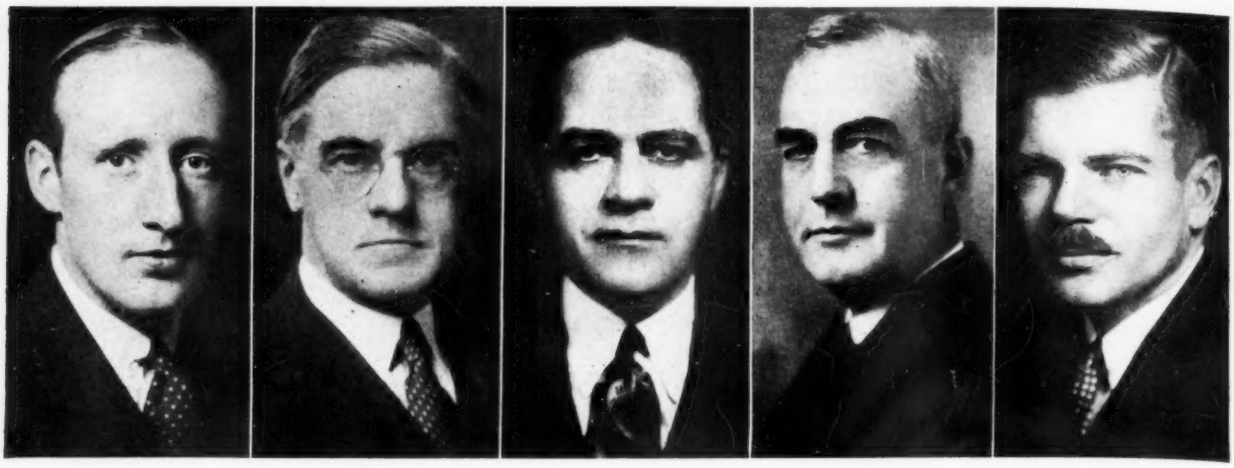
THOMAS A. MORGAN

NEW YORK ORDNANCE COÖRDINATORS

IN conformity with the Ordnance Department's policy of appointing civilian coördinators to assist the Ordnance Districts in the functional operations of their vast enterprises, the New York Ordnance District has announced that five leading executives in the New York area have accepted appointments. ARMY ORDNANCE, in succeeding issues, will publish short biographical sketches of the coördinators in the other districts. The five civilian executives from the ranks of industry in each district organization will assist in coördinating wherever possible in the fields of production, contracting, administration, purchase, and inspection. Col. J. K. Clement, Ordnance Department, is deputy district chief of the New York District. Brig. Gen. Samuel McRoberts, a director of the Army Ordnance Association, distinguished for World War service in the Ordnance Department, was formerly chief of the district and relinquished that office January 1, 1942. Thomas F. Brown, long an outstanding figure in Ordnance activities, is the assistant district chief. The five civilian coördinators who serve on a full-time basis as advisers to Colonel Clement are the following (see pictures on page 974):

R. H. Watson, Coördinator of Production.—Mr. Watson was graduated from Harvard in 1900, served with the Carnegie Steel Company from 1902 to 1928 as metallurgist assistant, metallurgist, second assistant general superintendent, superintendent open-hearth department, and assistant general superintendent. From 1928 to 1930 he was general superintendent of Homestead Steel Works; from 1930 to 1933, vice-president in charge of operations of Carnegie Steel Company; from 1933 to 1936, vice-president in charge of operations of United States Steel Corporation, and, from 1936 to date, Mr. Watson has been vice-president in charge of operations and raw materials of the United States Steel Corporation.

Elgood M. Lufkin, Coördinator of Contracting.—Mr. Lufkin was graduated from Yale in 1925, served successively with the Seaboard National Bank, which later merged with the Equitable Trust Company, and, when this bank merged with the Chase National Bank, he became a second vice-president of the latter. In 1931 he transferred to and became assistant vice-president of the Bank of New York, with which he has continued. He became vice-president in 1936. For the past two years he has been a director of Globe and Rutgers Fire Insurance Company.



Whitney Stone *F. M. Farmer* *E. M. Lufkin* *R. H. Watson* *Frederick Tomkins*

Coördinators of the New York Ordnance District

Mr. Whitney Stone, Coördinator of Administration.—Mr. Stone was graduated from Harvard in 1930 and has served with Stone & Webster since that date, formerly as vice-president and director and, since 1938, as executive vice-president. Mr. Stone is director of Stone, Webster & Blodget, Inc., Stone & Webster Engineering Corporation, and Research Corporation; a director and a member of the executive committee, Chicago, Wilmington & Franklin Coal Company, and other corporations.

Frederick Tomkins, Coördinator of Purchasing.—Mr. Tomkins was graduated from Williams College in 1916. From 1918 to 1921 he was manager of the Newark Plaster Company and has been its president since 1921. Since 1921 he also has been secretary of the United States Kalsomine Company and a director of the Bates Manufacturing Company. From 1923 to 1930 he was also president of the Albert Manufacturing Company, and, from 1930 on, a director of American Homes, Inc. Since 1931 he has been, in addition, president of the Tomkins Tidewater Terminal.

F. Malcolm Farmer, Coördinator of Inspection.—Mr. Farmer was graduated from Cornell University in 1899. He was a student engineer of the General Electric Company at Schenectady from 1899 to 1900, inspector with the United States Navy Department in Brooklyn from 1901 to 1903, lecturer at Cooper Institute from 1902 to 1906. He was technical assistant in the Electrical Testing Laboratories, New York, from 1903 to 1906, engineer from 1906 to 1912, chief engineer since 1912, and vice-president since 1929. Mr. Farmer is a Fellow of the American Institute of Electrical Engineers (president, 1939-1940), a member of the Electrical Standards Committee, American Association for the Advancement of Science, American Society of Mechanical Engineers, Institution of Electrical Engineers (British), American Society for Testing Materials (president, 1924-1925), American Welding Society (president, 1926-1938), American Standards Association (past director and past chairman, standards council), Engineering Foundation and United Engineering Trustees (vice-president).

University of Michigan Post

NEW officers of the University of Michigan Post of the Army Ordnance Association, elected at a special meeting held recently at the home of Maj. William E. Renner, Ordnance instructor in the Department of Military Science and Tactics, are Lawrence A. Shipman, president; Philip E. Sharpe, vice-president; Howard E. Strauss, recording secretary; and Charles M. Thatcher, 548 S. State Street, Ann Arbor, Mich., corresponding secretary.

Declaring that the people of the United States now face the most serious job they have ever had, Lieut. Col. L. A. Codd, Ord. Res., executive vice-president of the Army Ordnance Association, told student members of the University of Michigan Post and guests at the Post's recent annual banquet meeting that every one must "get behind this thing with all the power and all the energy you have! We all think we can't lose," he pointed out, "but it isn't the size of the dog in the fight, it's the size of the fight in the dog that counts. America must suffer as it has never suffered before if we are to get out of this scrap victorious."

Speaking on the subject "Victory through Arms Production," Colonel Codd revealed that continuing battle tests have definitely proved the superiority of American-made weapons, chiefly in Libya and Bataan, where General MacArthur has given high praise to the well-known Garand rifle and the American light tank. Emphasizing the increasing importance of maintenance and supply in ordnance work, Colonel Codd observed that mechanized warfare has made this phase more important than ever before, and the manufacture of spare parts is every bit as important as the production of the complete article.

Ordnance men have kept a plan for industrial mobilization up to date since the end of the last war, he revealed, but that plan unfortunately has not been followed in many respects. "The guiding principle of our production to date has been centralized control over decentralized operation," Colonel Codd stated. "We owe much to American industry for the coöperation it has given to the arms program."

Swelling the ranks of R.O.T.C. and engineering students who attended the banquet were fifteen representatives of the Detroit Ordnance District, headed by William E. Hurley, assistant chief of the district; University faculty men, representatives of the Naval R.O.T.C., and a number of local business men. Other distinguished guests, in addition to Mr. Hurley, were Capt. Cassidy, head of the N.R.O.T.C.; Col. W. A. Ganoe, head of the R.O.T.C.; John Podesta, of the American Broach & Machine Company; and Col J. A. Bursley, dean of students. Major Renner acted as toastmaster.

Speakers at other recent meetings of the University of Michigan Post have been Francis J. LaPointe, of the American Broach & Machine Company, who spoke on "The Broaching Industry"; Col. H. W. Miller, noted authority on artillery, who spoke on "Present Research in Ordnance"; and Colonel Ganoe, who spoke on "Industrial Relations."

Cincinnati Post

AT the recent annual election of officers of the Cincinnati Post the following were elected: President: August H. Tuechter; vice-president: Col. A. H. Pugh; directors for 1942-1943: F. V. Geier, A. F. Hubbard, H. C. Knowles, and C. H. Kindl; direc-

tors for 1942: E. A. Muller, F. L. Burke, C. W. Wheland, and Louis Schwitzer; director of the national Association: J. B. Doan; secretary: Col. Fred A. McMahon.

Boston Post

A JOINT meeting of the Boston Post, Army Ordnance Association, and the Boston Chapter, American Society of Metals, was held in Boston on the evening of April 10th. Brig. Gen. Earl McFarland, Assistant to the Chief of Ordnance, was the principal speaker. Speaking on "Metallurgy and Our Armament," General McFarland said in part:

"The Ordnance Department of the United States has stimulated an active concern for better metals for defense while at the same time sharing its progress with industry, just as private industry and research have continuously shared and coöperated with the Department. The results of this joint trusteeship are now paying dividends of untold worth. Your steel mills, now operating at nearly maximum capacity, are turning out a quality of steel the like of which would have given our Ordnance forebears a sense of gratification that their dreams were not vain. The metallurgy of our guns and ammunition, of our fighting vehicles, our bombs, our small arms, and all the accoutrements of modern battle represent a degree of technical progress which no other country on earth can surpass.

"Indeed, the great effort of the moment is to conserve metallurgical power for our armament needs and therefore to search for substitutes wherever they can be found and apply them not only to civilian needs, but to military and naval needs as well. According to a recent War Department announcement, manufacturing economies which will be useful to civilian consumers long after the war is over are being developed for Army use and already have resulted in reducing consumption of 125 raw materials now listed as strategic and critical. Each branch of the Army is contributing something to the study in conservation. The Ordnance Department has successfully substituted steel for aluminum in mine fuzes and bomb fuzes. Steel and malleable iron have replaced aluminum in gun carriages and mounts for machine guns. With the exception of fans and motors, aluminum is being eliminated from the interiors of tanks."

The officers of the Boston Post who participated in arrangements for the meeting are: Lieut. Col. C. S. Robinson, president; C. W. H. Cowdrey, vice-president; Col. T. L. Ames, R. J. Thanisch, Maj. M. T. Carney, A. E. Anderson, Col. C. E. Fuller, W. Van Pattensteiger, and Maj. R. E. Goho, directors; Archibald McMillan, treasurer; and Lieut. Col. J. S. Crawford, secretary.

Necrology

ALEX DOW, chief of the Detroit Ordnance District and a life member of the Army Ordnance Association, died March 22, 1942, at Ann Arbor, Mich., after a brief illness. He was a leading factor in the program of industrial mobilization during the past twenty years and had merited a high place among the executives of American industry whose coöperation brought industrial-mobilization planning to such a high degree of perfection.

On the occasion of the Association's Twenty-Second Annual Meeting at Detroit last October, Mr. Dow extended greetings to the members at the first session of that gathering when his jovial manner and kindly influence again were exhibited among so many of his friends. He had brought the Detroit Ordnance District to a high degree of successful operation both in peace and in war. Today, that district carries a war load which, by former standards, far exceeds any anticipated requirement.

Mr. Dow was born in Glasgow, Scotland, where he received his elementary education. He became an employee of the Cunard Steamship Line in Liverpool at the age of eighteen, devoting his spare time to the study of marine engines. After a brief service in the British Army, Mr. Dow came to Baltimore in 1882 where he was employed in various departments of the B. & O. Railroad. Here he first became interested in electricity and in 1888, having joined the British Electric Company of Cleveland, entered the manufacture of dynamos and other electrical machines. In 1893 he went to Detroit to design and supervise the construction of the city's public lighting system. Three years later he became associated with the Edison Illuminating Company, forerunner of the Detroit Edison Company. He became president of the latter in 1912, serving until 1940 when he became chairman. It was largely under his direction that the Detroit Edison Company expanded into one of the foremost utilities in the country.

In the death of Mr. Dow the Ordnance cause has lost one of its foremost exponents. How deep was his devotion is best shown by the following incident: In the days when public funds for the development of ordnance manufacturing processes were so meager, Mr. Dow personally and at his own private expense bought types of costly machine tools and presented them to the Frankford Arsenal for the study of faster production methods. This work today is reaping dividends for the armed forces of the United States beyond any calculation and is materially responsible for the accelerated production of artillery ammunition. ARMY ORDNANCE shares the sorrow of Mr. Dow's many friends and also the thanks which are so abundantly his for his leadership and example.

S. FORRY LAUCKS, president of the York Safe & Lock Company and an active member of the Army Ordnance Association, died at his home, "Lauxmont," Wrightsville, Pa., April 11, 1942. He was internationally known as a builder of bank vaults and since 1938 had been one of the nation's largest manufacturers of ordnance. Born in York County in 1870, Mr. Laucks had been connected with the York Safe & Lock Company since he was seventeen years of age. Long identified with the design and building of safes and bank vaults in use throughout the world, Mr. Laucks turned his abilities to the manufacture of ordnance in 1938 and became the first private manufacturer of gun mounts in the United States since the World War. Starting on an original order with fifty subcontractors, York Safe & Lock Company at the beginning of this year had several hundred subcontractors on its list.

For many years Mr. Laucks had taken an active part in the affairs of the Army Ordnance Association. More recently he became a member of the Association's Ordnance Endowment Committee and had been of great value to that group in furthering the purposes of the endowment. He was a kindly gentleman of deep patriotism as is also typified in the organization he headed. His loss at this time is all the greater because of the void it leaves in the official as well as in the personal contacts of his many friends.

NOTICE also has been received of the death of the following members of the Association: A. Aigeltinger, New York, N. Y.; Erwin J. Benz, Ann Arbor, Mich.; Harry C. Bills, Detroit, Mich.; Robert C. Boger, Philadelphia, Pa.; Lee R. Brown, Orange, N. J.; Donald E. Dickey, Kirkwood, Mo.; S. W. Dimick, Hartford, Conn.; George W. Farny, Morris Plains, N. J.; L. F. Fedders, Buffalo, N. Y.; Paris R. Forman, Rahway, N. J.; Frederick H. Franklin, East Providence, R. I.; Robert T. Howes, Akron, Ohio; George F. Hurt, New York, N. Y.; Andrew W. Keegan, Sr., Clifton Heights, Pa.; W. R. Kern, New York, N. Y.; Bradley H. Kirschberg, Schenectady, N. Y.; Alexander Lowy, Pittsburgh, Pa.; P. E. McKinney, Bethlehem, Pa.; Warren R. Palmer, Norwalk, Conn.; R. S. Papworth, Cleveland, Ohio; Helmuth Pedersen, Warrenton, Mo.; William O. Steele, New York, N. Y.; Clifford S. Stilwell, Cleveland, Ohio; William G. Wall, Boyds, Md.; Charles J. Westin, Philadelphia, Pa.; George S. Wilson, San Francisco, Calif.; William H. Winterrowd, Philadelphia, Pa.

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Ordnance in Review

The Machine Gun—A Period of Evolution, Part I

Lieut. Col. Calvin Goddard

This is the first of a new series of articles on the machine gun by Colonel Goddard. The previous series, entitled "The Machine Gun—Its Early Applications," was begun in the September-October 1941 issue and was concluded in the March-April 1942 issue. The latter series has now been reprinted in brochure form and copies are available without charge to readers of Army Ordnance *upon application to the Editorial Offices, Mills Building, Washington, D. C. The present series also will be reprinted when it is concluded.*

For every machine gun which actually went into production during the period 1860-1870, scores of others took shape in the minds of inventors the world over, for this was a period replete

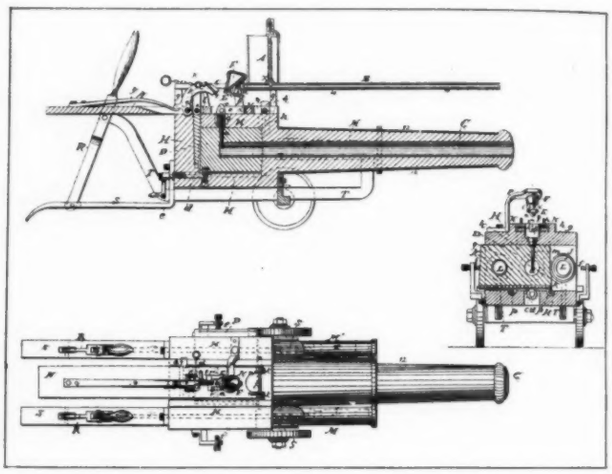

Fig. 1. The Terrel Machine Cannon, 1856

with wars and rumors of wars. And while most of these obviously died aborning, not a few, including some truly terrible in design and execution, managed to struggle to and through patent offices, mostly to expire soon thereafter. Among the multishot and rapid-fire weapons of this era recorded in the files of the U. S. Patent Office, we come upon the following:

Patent No. 14,215, February 5, 1856, by Chas. C. Terrel, of Shullsburg, Wis. (Fig. 1). While this contrivance was properly a small fieldpiece, it deserves mention since it constituted, in effect, an ancestor of the machine-gun cannon, a type to which much time and effort has been devoted in recent years. A crank-operated rack and pinion shifted from right to left in a rectangular slot cut horizontally through its breech casing a breechblock of similar (rectangular) section. This served to bring first one, then the second, of two chambers cut into the block in line with the bore of the single barrel (see illustrations), leaving one chamber exposed for loading while the other was in firing position. The whole mechanism was somewhat reminiscent of that found in the "harmonica" pistol of early pin-fire days. Handled by a trained crew and supplied with an adequate store of ammunition, it should have been capable of a rapidity of fire considerably greater than that common to the period.

Another early machine cannon was patented July 8, 1856, by C. E. Barnes, of Lowell, Mass. (Patent No. 15,315, Fig. 2). Loading and firing were accomplished through the operation of a hand crank which caused a plunger-breechblock to recipro-

cate in line with the bore. Fixed cartridges fed from a tray on the left of the breech were rammed home and discharged by an automatic priming device on the forward movement of the plunger. The rate of fire depended only upon the dexterity with which the gun crew could supply ammunition to the loading tray.

On October 2, 1861, was patented by Ezra Ripley, of Troy,

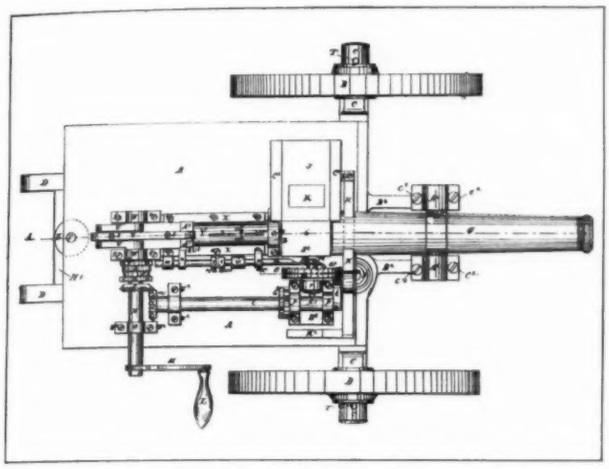

FIG. 2. THE BARNES MACHINE CANNON, 1856

N. Y., a machine weapon which he described as an "Improvement in Repeating-Gun Batteries" (Patent No. 33,544, Fig. 3). One wonders whether a knowledge of the existence of this device may not have given Gatling the glimmerings of an idea from which he finally elaborated his own design. In appearance the two are decidedly similar, though the resemblance there ends. For, while the barrels of the Gatling revolve about its central spindle, those in Ripley's piece remain stationary, volume of fire being achieved through the employment of removable breech pieces, each pierced circumferentially with as many chambers as the gun possessed barrels. When one of these was set in place and locked in position, its chambers severally registered with the bores of the rifled tubes ahead. Rotation of a

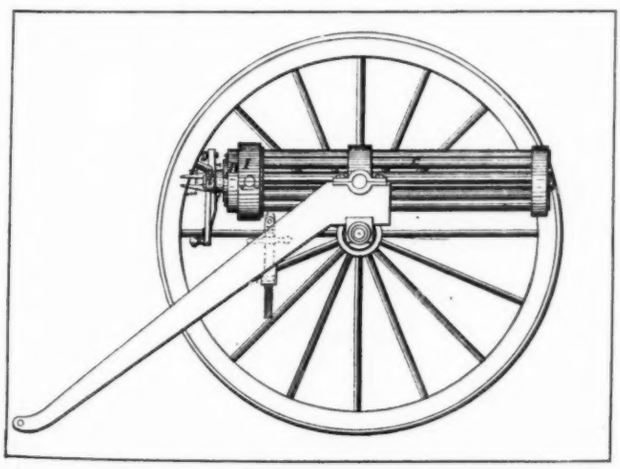

FIG. 3. THE RIPLEY MACHINE GUN, 1861

hand crank now effected the discharge, in sequence, of the contents of the chambers, ignition being through the medium of conventional percussion-capped nipples. Rate of fire varied directly with the speed at which the crank was rotated, the number of missiles constituting a single "volley" being limited by the number of barrels incorporated in each particular gun. Thus, in the

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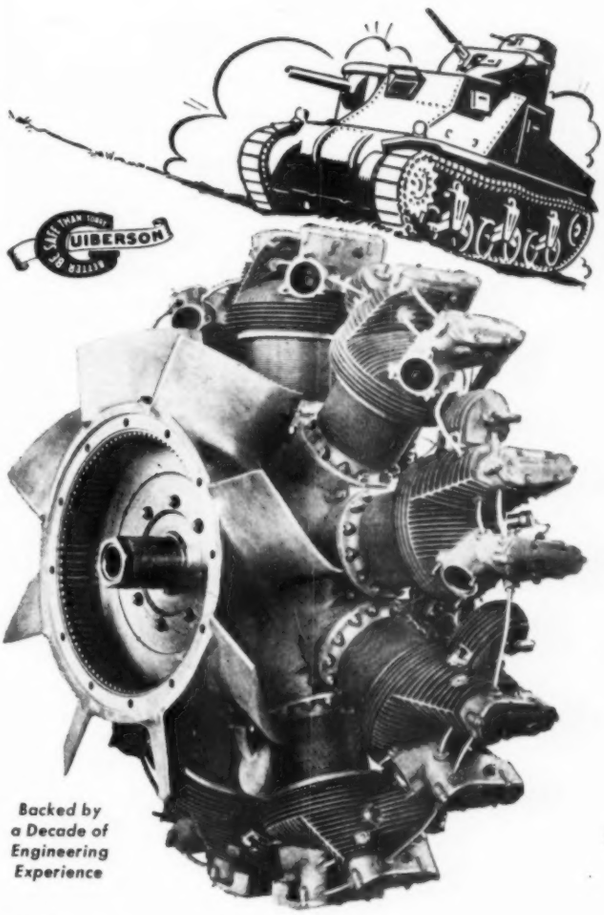

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Ordnance in Review

specimen shown, a total of nine shots could be discharged, either singly, or in a second or two, at the will of the operator. At least four spare loaded breech pieces were supplied which, with the one in place on the piece, furnished a total of forty-five rounds available before replenishment became necessary.

To Gatling's quick mind, study of the design of this weapon readily could have suggested an improvement in the form of rotating barrels and fixed ammunition fed from an overhead hopper, as embodied in his own first model developed the year following. And although we have uncovered no direct evidence to prove his acquaintance with Ripley's invention, it is highly probable that, as the war clouds gathered, the resourceful doctor, long an inventor in his own right, was keeping a careful eye on patent disclosures of all kinds—not forgetting those in the field of ordnance.

PERHAPS the most fearful and wonderful of multishot weapons patented during the Civil War period was the "Flying Gun and Bayonet Battery" of Joel W. Andrews, of Norristown, Pa. (Patent No. 33,731, November 19, 1861, Fig. 4). Study of the patent drawings shows it to have embodied some seven carbines and seventeen bayonets mounted on a wooden framework terminating in two shafts (*T*) between which a horse was to be harnessed as motive power. From an armored sentry box (*S*)

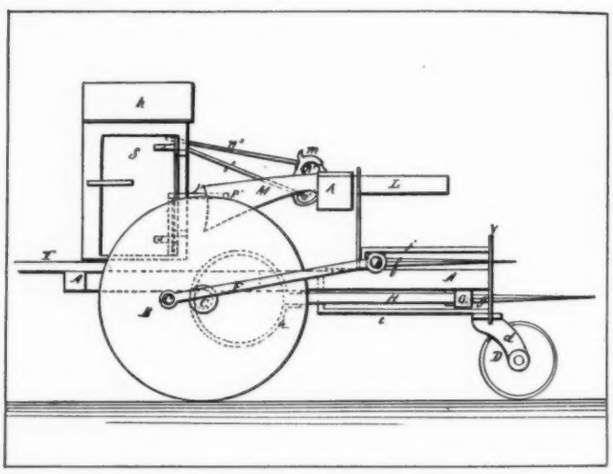

FIG. 4. THE "FLYING GUN AND BAYONET BATTERY," 1861

its intrepid operator could cock hammers and press triggers mechanically by traction on rods n^2 and o^2, while the eccentrics attached to wheel *B* caused the two rows of bayonets to reciprocate fearsomely as the juggernaut advanced. Volume of fire was limited to the number of carbines carried, leaving the manipulator virtually defenseless, save for his bristling bayonets, once the chambers of his seven single-shot weapons had been emptied, for there is nothing in drawing or description to indicate that the employment of repeating arms was contemplated. (Suggestion *is* made in the specifications, however, that he may fire small arms from slits in the conning tower.) And the successful manipulation of the vehicle must have required the services of a horse gifted with no less than human understanding—apt at reversing his position at word of command and of harnessing himself without external aid. For (quoting from the specifications) "his head is toward the machine in the semicircle when in pursuit or in action, but in retreating or going to the field of action, the horse is reversed."

Fortunately, no specimen of this monstrous engine appears to have faced an enemy in actual combat. Had such a meeting occurred, the results (with respect to its luckless operator and equine transport) could hardly have been short of disastrous.

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Brass, Cartridge

Physical properties of brass cartridge cases. R. S. Pratt. *Mechanical Engineering,* February 1942, p. 119.

Explosives

Canada's war-time explosives and chemical program. J. R. Donald. *Canadian Chemistry and Process Industries,* December 1941, p. 686.

Forging

Crystal structure in steel and the effect of hot and cold work. Discussion of distinction between "hot" and "cold" work, control of grain flow, forms of crystal structure, crystallization, slippage, effect of cold work on crystal structure, fatigue failure. Arthur F. Macconochie. *Steel,* February 16, 1942, p. 66.

Armament Reference

Forgings in the war of machines. Waldemar Naujoks. *Heat Treating and Forging,* January 1942, p. 19.

Important factors on forging practice. Includes references to early forging practices; relation of dendritic structure to grain flow; major practical considerations governing forging practice; influence of inertia on the flow of the metal; mathematical analysis of forces acting on a slug to determine radial force in terms of intensity of vertical pressure and coefficient of friction; limits of the diameter-thickness ratio in a forging operation. Arthur F. Macconochie. *Steel,* February 23, 1942, p. 60.

Gages

Important points on gages and gaging procedure. G. H. Stimson. *Machinery,* February 1942, p. 119.

Gasoline Storage

Protection of gasoline storage in war. W. A. Austin, Jr. *The Military Engineer,* February 1942, p. 76.

Honing

Honing in airplane and gun production. *Machinery* (London), January 15, 1942, p. 452.

Hygiene, Industrial

Industrial hygiene at work in defense industries. Warren A. Cook. *Metal Finishing,* January 1942, p. 19.

Keep 'em rolling. Alexander McCausland. This article, prepared for safety engineering and authorized by the War Department, is both timely and instructive. It presents the organization and function of a medical department in a large munitions plant. *Safety Engineering,* January 1942, p. 34.

Industrial Heating

Furnaces for cartridge cases. *Industrial Heating,* January 1942, p. 20.

Inventions

Invention. War inspires—law protects. George V. Woodling. *Machine Design,* February 1942, p. 55.

Machine Guns

Cleaning machine-gun barrels after proof firing. *Defense Data,* January 1942, p. 16.

Super machine gun. J. B. Nealey. Brief descriptions of the 37-mm. and 40-mm. antiaircraft and antitank weapons. *The American Rifleman,* February 1942, p. 8.

Ordnance Manufacture

From butter to guns. Maj. Paul L. Reed. American industry is doing the job that needs to be done—and doing it at an accelerated speed that will put ample guns and ammunition into the hands of the fighting men. *The Coast Artillery Journal,* January-February 1942, p. 44.

Photography, High-Speed

Aid for analyzing high-speed action. Abstract of article published in the *General Electric Review,* October 1941. *Journal of the American Society of Naval Engineers,* February 1942, p. 97.

Plant Protection

Adequate lighting for plant protection. Explains technique for protecting plants against saboteurs and other intruders. Lindsay M. Applegate. *Electrical West,* January 1942, p. 41.

Defense measures for plant security. Résumé of antisubversive measures and passive-defense activities based upon British experience in protecting power plants, substations, and system facilities. *Electrical West,* January 1942, p. 34.

Defense of manufacturing plants. D. L. Fiske. Brief outline of program of industrial plant protection. *Refrigerating Engineer,* Vol. 43, January 1942, p. 15.

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Defense Library

Timely Books

THE following books have been added recently to the library of the Army War College, Washington, D. C. They constitute a timely list of texts on various aspects of national defense. Army Ordnance *acknowledges with thanks the permission of Lieut. Col. R. B. Hough, Jr., librarian, to publish the list.*

Barnes, William Croft.—*Apaches and longhorns.* Los Angeles: Ward Ritchie Press, 1941. Reminiscences of the real life of the West.

Beard, Charles Austin.—*Public policy and the general welfare.* New York: Farrar & Rinehart, 1941. Reappraises the rôle of government in the light of our ideological heritage and the domestic problems of recent years.

Benns, Frank Lee.—*Europe since 1914.* New York: Crofts & Co., 1941 (fifth edition). The outbreak of the Second World War and subsequent developments have called for important revisions and additions in this standard history of current Europe. This edition covers the immediate background of the new war and its course to date.

Burdick, Usher Lloyd.—*Last days of Sitting Bull.* Baltimore: Wirth Brothers, 1941. Based chiefly upon valuable papers, documents and letters left among the effects of the late Maj. James McLaughlin, agent and inspector among the Sioux for a half century.

Carr, Albert.—*Napoleon speaks.* New York: Viking Press, 1941. A unique study of Bonaparte as revealed in his own letters—behind the scenes of a dictator's mind.

Casey, Robert Joseph.—*I can't forget.* Indianapolis: Bobbs-Merrill, 1941. Personal experiences of a war correspondent in France, Luxembourg, Germany, Belgium, Spain, and England.

Ching-Chun, Wang.—*Japan's continental adventure.* New York: Macmillan, 1941. Studies on various important phases of Japan's invasion of China.

Clark, Thomas Blake.—*Paradise limited.* New York: Modern Age Books, 1941. A treasury of good yarns which add up to a real history of the Hawaiian Islands.

Cooke, David C.—*War wings.* New York: R. M. McBride, 1941. A complete record—in both text and picture—of the fighting planes of the democracies.

Cudahy, John.—*The armies march.* New York: Scribner's, 1941. The former Ambassador Extraordinary to Poland, Minister to the Irish Free State, and Ambassador to Belgium records his experiences in Europe.

Daniell, Raymond.—*Civilians must fight.* New York: Doubleday, Doran, 1941. The blood, sweat, and tears of an island kingdom defending itself as seen by an American newspaper man.

Davis, Forrest.—*The Atlantic system.* New York: Reynal & Hitchcock, 1941. Survey of Anglo-American relations in terms of sea power, strategy and coöperative diplomacy.

DeJong, L.—*Holland fights the Nazis.* London: L. Drummond, 1941. An account of life in Holland under Nazi rule.

DeWeerd, Harvey Arthur.—*Great soldiers of the two world wars.* New York: W. W. Norton, 1941. Presents the portraits of great soldiers of the two world wars and shows their contributions to military science and military thought.

Duranty, Walter.—*The Kremlin and the people.* New York: Reynal & Hitchcock, 1941. An interpretation of what has happened to Russia and what Russia means to the democracies.

Feuchtwanger, Lion.—*The devil in France.* New York: Viking Press, 1941. The author passed the summer of 1940 in French concentration camps. He ascribes the evil he and others experienced to the incapacity rather than the malice of those responsible.

Fodor, Marcel William.—*The revolution is on.* Boston: Houghton Mifflin, 1940. Describes the forces working behind the present world-wide convulsion.

Forbes-Robertson, Diana.—*The battle of Waterloo road.* New York: Random House, 1941. Around the clock with an English family during an air raid.

Gamow, George.—*Biography of the earth.* New York: Viking Press, 1941. The life story of the earth.

Goodspeed, Thomas Harper.—*Plant hunters and the Andes.* New York: Farrar & Rinehart, 1941. Some of the Peruvian and Chilean accomplishments and experiences of members of two plant-hunting expeditions sent out by the University of California Botanical Garden are described.

Johnston, Samuel Paul.—*Flying fleets.* New York: Duell, Sloan, & Pierce, 1941. Significant aspects of naval aviation history; the photographic section contains a superb collection of over 200 pictures.

Ley, Willy.—*Bombs and bombing.* New York: Modern Age Books, 1941. The author is concerned with studying just what air power has actually done and what it conceivably can do toward physically destroying animate and inanimate objects.

Lombard, Helen.—*Washington waltz.* New York: Knopf, 1941. A former official hostess of the French Embassy tells how foreign diplomats really do their work and how they fool American statesmen—sometimes! Witty, shrewd, and candidly revealing.

Lovette, Leland Pearson.—*School of the sea.* Philadelphia: F. A. Stokes, 1941. Written to give the layman some comprehension of what Annapolis actually is and what it has contributed to the life of our nation. Presents also the relations between the Naval Academy and the Navy.

Ludwig, Emil.—*The Germans; double history of a nation.* Boston: Little, Brown, 1941. Devotes only a few pages to Hitler and over 400 to the history of Germany, from the time when Ariovistus insolently defied Cæsar's legions to the year 1933.

Lytle, Andrew Nelson.—*At the Moon's Inn.* Indianapolis: Bobbs-Merrill, 1941. Story of the expedition into Florida, headed by Hernando de Soto, who had taken part in the conquest of Peru.

McGovern, William Montgomery.—*From Luther to Hitler.* Boston: Houghton, Mifflin, 1941. The history of Fascist-Nazi political philosophy.

McInnis, Edgar.—*The war, second year.* London: Oxford University Press, 1941. An account of the second year of the present war, up to September 1941.

Madariaga, Salvador de.—*Hernan Cortez, conqueror of Mexico.* New York: Macmillan, 1941. This is as much a history of the conquest of Mexico as a biography of its conqueror.

Maloney, John.—*Let there be mercy; odyssey of a Red Cross man.* New York: Doubleday, Doran, 1941. John Maloney, war correspondent, world traveler, and former Red Cross public-relations officer, here gives the odyssey of a Red Cross man in Europe during the opening year of the present war.

Martin, Chester.—*Canada in peace and war.* New York: Oxford University Press, 1941. Eight studies in national trends since 1914.

Masefield, John.—*Conquer: a tale of the Nika rebellion in Byzantium.* New York: Macmillan, 1941. An account of the faction struggle which nearly caused the complete destruction of Byzantium in the first week of the year 532.

Matthews, Blayney F.—*The specter of sabotage.* Los Angeles: Lymanhouse, 1941. Designed to thwart sabotage attempts in America, this book outlines safety measures that should be taken by the employee, the citizen, and the industrialist.

Mullendore, William Clinton.—*History of the United States Food Administration, 1917-1919.* Palo Alto: Stanford University Press, 1941. An official record of the activities of the organization through which the American people and food industries voluntarily coöperated to assure not only adequate supply and distribution of food in this country but also feeding the Allies during the World War and Europe after the Armistice.

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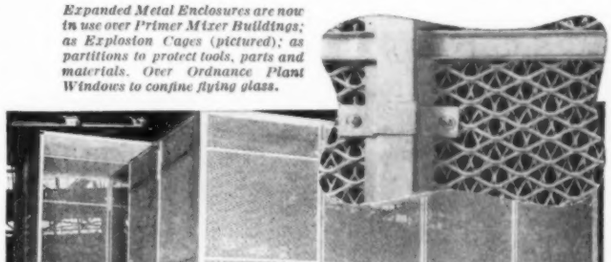

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Defense Library

Necker, Wilhelm.—*Hitler's war machine and the invasion of Britain.* London: Drummond, 1941. Lays bare the anatomy of the Hitler war machine. Revolutionary changes have completely transformed every department of warfare.

Rich, Bennett Milton.—*The Presidents and civil disorder.* Washington: Brookings Institution, 1941. A study of the rôle of the Chief Executive in domestic disturbances involving the armed forces of the U. S.

Riess, Curt.—*Total espionage.* New York: Putnam, 1941. Describes how the enormous espionage organization of the Third Reich was started, how it functioned, and what successes it had during the so-called peaceful Hitler period and the time of his bloodless victories to the present.

Robinson, William Morrison.—*Justice in grey.* Cambridge: Harvard University Press, 1941. A history of the judicial system of the Confederate States of America.

Sargeaunt, Henry Antony.—*Grand strategy.* New York: T. Y. Crowell Co., 1941. The evolution of modern war is traced from the grand strategy of Napoleon to the comprehensive strategy of the protagonists of the present day. Stresses the importance today of timed action and morale.

Sizoo, Joseph Richard.—*On guard.* New York: Macmillan, 1941. Written to help meet the urgent personal spiritual needs of men in our fighting forces.

Smith, Henry Ladd.—*Airways.* New York: Knopf, 1942. A history of commercial aviation in the United States.

Thompson, Virginia McLean.—*Thailand: the new Siam.* New York: Macmillan, 1941. The story of a nation that for centuries displayed the pomp and splendor of an absolute monarchy and which later became a vigorous democracy.

Townsend, Mary Evelyn.—*European colonial expansion since 1871.* Philadelphia: Lippincott, 1941. An account of the modern colonial overseas empires constructed by the European powers since 1871.

West, Rebecca.—*Black lamb and grey falcon.* New York: Viking Press, 1941. A travel diary of a trip through Yugoslavia in 1937.

Williams, Thomas Harry.—*Lincoln and the radicals.* Madison: University of Wisconsin Press, 1941. Story of the 4-year duel between the President and the Republican extremists.

Young, Kimball.—*Personality and problems of adjustment.* New York: F. S. Croft Co., 1941. Designed essentially to be a college text in courses dealing with the psychology of personality or with the problems of mental hygiene and to serve as an orientation to the interplay of personality, society, and culture.

Ziemer, Gregor A.—*Education for death.* London: Oxford University Press, 1941. Dr. Ziemer, for several years director of a school for American children in Berlin, made a special study before he left Germany of Nazi education of youth, and he has written this account of what he says he saw and heard.

INDEX TO ARMY ORDNANCE, VOLUME XXII

The index to Volume XXII of ARMY ORDNANCE, *with title page for binding, is now being prepared. It is arranged alphabetically by subject and author and covers the July-August 1941 issue (No. 127) to the May-June 1942 issue (No. 132), inclusive. Copies may be obtained without charge upon application to:*

The Editorial Offices, Army Ordnance Association
705 Mills Building, Washington, D. C.

Book Reviews

SEA POWER IN CONFLICT. By Paul Schubert. New York: Coward-McCann. $2.50.

THIS up-to-the-minute, inclusive, and thought-provoking volume fills the need for a study of modern naval warfare. While not styled as an advanced textbook, it is by no means a primer. It is factual condensation with able analysis. It should prove invaluable to the layman and of real time-saving value to the officer and the advanced student. Paul Schubert, the author, is a graduate of Annapolis, a former officer of our fleet. For years he has been a writer and commentator on sea power. He has a graphic, lucid style and presents his text to the reader as a series of photographic impressions.

After a short definition of the problems of today's naval warfare, Mr. Schubert points that primary truth which America's people are so bitterly learning: That well-equipped and strongly held bases are of the first importance. Then follows a summary of the navies of all the powers: their ships, their aims, their traditions, and their hidden as well as apparent strengths and weaknesses. The chapter on the United States Navy is a tonic in these dreary days of waiting and of heavy losses. And the tremendous import of the use of the American and British fleets as one "2-ocean navy" is well noted.

The chronological arrangement of the important actions which involve sea power gives a short naval history of the present war to and including Pearl Harbor, and also develops the author's appraisement of the new sea power. The factual yet thrilling narrative of the GRAF SPEE, Narvik, Dunkerque, and the BISMARCK, lead the reader to look to the future with high hope. This much is shown by a glorious record: Fighting ships of neither the American nor the British fleets break off action while they can float and shoot!

The lesson of Norway and Crete is here well written. Possibly the most valuable contributions of this book are (1) the author's analysis of just what can and cannot be done by ships in the face of shore-based airplanes, and (2) the fact that air power, whether based on sea or shore, becomes sea power whenever used over the sea. He never begrudges air power its full dynamic vigor, yet avoids the all-too-easy overvaluation which is so common in times of change and stress. Schubert's summation, this reviewer believes, is incontrovertible: Teamwork, and teamwork alone, coupled with attack, is the only formula for success on sea as on land.

F. W. FOSTER GLEASON.

A FORGOTTEN HERITAGE—THE STORY OF THE EARLY AMERICAN RIFLE. By Harry P. Davis. Huntington: Standard Printing and Publishing Company. $4.

THIS is really a history of the rifle in America. No less an authority than Capt. John G. W. Dillin, renowned author of "The Kentucky Rifle," has appraised the volume thus: "Those who well appreciate true history and romance of pioneer days along with authentic details in the influence of our first rifle in the life of our nation will find in 'A Forgotten Heritage' by my old friend, Harry P. Davis, a publication I am pleased to recommend to my friends." Praise from John Dillin is praise indeed!

Mr. Davis has set for himself the pleasant task of picturing in their true light the historical background and achievement of the early pioneers in America who made possible the birth and development of the American rifle. The famed Kentucky rifle was developed in the log-cabin workshop of backwoods America. It is of the people connected with the beginning of that great de-

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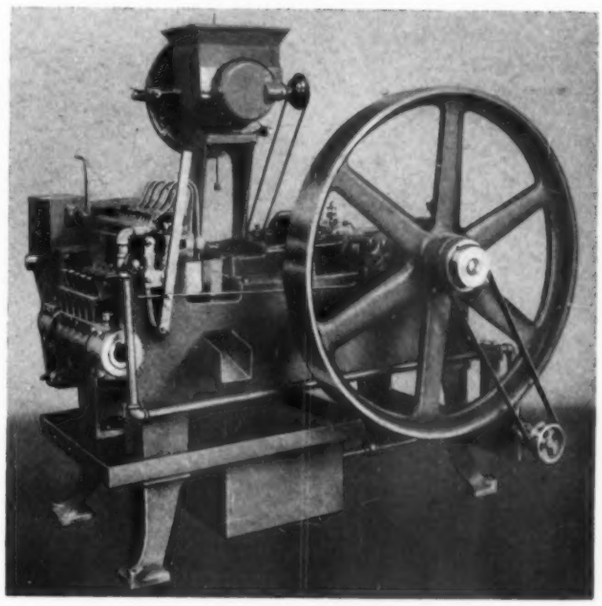

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Book Reviews

velopment, the human incidents which surround it, and the character of the individuals—men and women—whose perseverance brought ultimate success—it is of these that Mr. Davis writes with clarity and fascination. His book is more than timely in these days when American arms have again come into their own.

N. A. WOODHOUSE.

ENCYCLOPEDIA OF AMERICAN HAND ARMS. By George Morgan Chinn, Jr., and Bayless Evans Hardin. Huntington: Standard Printing and Publishing Company. $8.

THIS beautifully prepared text is the handiwork of two Kentuckians. George Morgan Chinn, Jr., member of the Kentucky State Historical Society and student of firearms, is a descendant of a long line of Kentuckians who settled in that State in 1784; Bayless Evans Hardin is an officer of the Kentucky State Historical Society whose forebears settled in the Blue Grass State during the Revolutionary War.

To say that a book is an encyclopedia is to describe it in one word. But in this case, every subject described has accompanying it, in color, a picture of the piece itself. How broad the subject matter is best understood if the reader realizes that here is a classification of American short arms from their beginning in the early eighteenth century through to the present time. Three hundred and eighty-two pieces are described and illustrated. In addition, there are excellent accounts of the general history of small arms; a treatise on Colt's arm; a list of American and foreign hand-arms makers who contributed something to the hand-arm industry but many of whose products did not deserve illustrating in the encyclopedia. There is also a list of hand arms which were marked with only the "brand" name and advertised and sold, in most instances by mail-order houses, in the years 1890 to 1910. Finally, there is the list of American hand-arms makers and their major and minor pet improvements.

Every student of hand arms the country over will join in a vote of thanks to Messrs. Chinn and Hardin for their painstaking work and to the Standard Printing and Publishing Company of Huntington, W. Va., for a fine piece of typography.

R. E. LEWIS.

THE TOOLS OF WAR. By James R. Newman. New York: Doubleday, Doran & Company. $5.

THIS is a decidedly elementary discussion of all types of armament—military and naval. It should have a useful purpose to fill in acquainting the general public with some of the basic considerations which could be found in many other sources but only with considerable trouble. There is a vast amount of historical data assembled here in the presentation of which the human-interest angle has not at all been overlooked. What Mr. Newman has tried to do within the confines of one book is possible only in mere outline. But the book has the earmarks of the "merchants-of-death" technique, and about such things ARMY ORDNANCE is always skeptical.

L. A. CODD.

AMERICA ORGANIZES TO WIN THE WAR: A HANDBOOK OF THE AMERICAN WAR EFFORT. New York: Harcourt, Brace and Company. $2.

THIS is an analysis of many of the angles, military, economic, and social, entering into the current war effort in the United States. Some twenty authorities have contributed chapters on their various specialties, some of which have a direct and intimate relation to the victory program but others of which are obviously far-fetched. We regret that of the twenty chapters there is not one which is a hard-fisted, double-barreled attack for real seriousness and concerted effort. Some day, somebody, somewhere will prepare a volume which will be not quite so much

Book Reviews

in the mold of Pollyanna and a bit more after the fashion of Washington and Taylor and Grant and Lee. We need it!

M. E. FERRITER.

WEATHER AND THE OCEAN OF AIR. By Maj. William H. Wenstrom. Boston: Houghton Mifflin Company. $4.50.

MAJOR Wenstrom has written one of the most interesting discussions of that most-discussed of all topics—the weather. This text is exhaustive in treatment, fascinating in presentation, and of such deep scholarship that it deserves to become a standard reference work. The author gives a graphic picture of the envelope of air in which we live and of the means and instruments through which we explore it. The science of weather forecasting which has developed enormously in recent years is explained in detail. The reader is told not only how to interpret a weather map intelligently, but how to draw one himself, and how to construct a home observatory as well as how to predict the weather from local signs and observations. Major Wenstrom was meteorological officer at Bolling Field, D. C., for three years, after having spent considerable time as an officer in charge of the U. S. Army weather stations throughout Pennsylvania, Maryland, and Virginia. Weather in war time is often a matter of life and death. Here is an authoritative book on the new science of weather prepared especially for the general reader who will find it of surpassing value. J. C. DUNBAR.

HISTORY OF THE ASSOCIATION OF MILITARY SURGEONS OF THE UNITED STATES—1891-1941. By Col. Edgar Erskine Hume. Washington: The Association of Military Surgeons.

COLONEL Hume is a writer of distinction on medical and military subjects. He is a former editor of *The Military Surgeon*, journal of the Association of Military Surgeons of the United States. Here he presents a definitive history of the society, its contribution to military medicine and the organization and men who have made that contribution possible. No national professional society can boast a more complete, objective, and authoritative history of its transactions during fifty years. R. E. LEWIS.

ARMS AND THE AFTERMATH. By Perrin Stryker. Boston: Houghton Mifflin Company. $1.75.

MR. Stryker has put together an unusually smart-aleck kind of description of our war effort up until now. He is a former feature writer for *Fortune* magazine and a specialist in popular presentation of industrial subjects. This is a so-called inside report on the economic and social upheaval that has begun to dislocate our lives. From our point of view, we do not see that his volume is much of a contribution one way or the other for the present effort. L. A. CODD.

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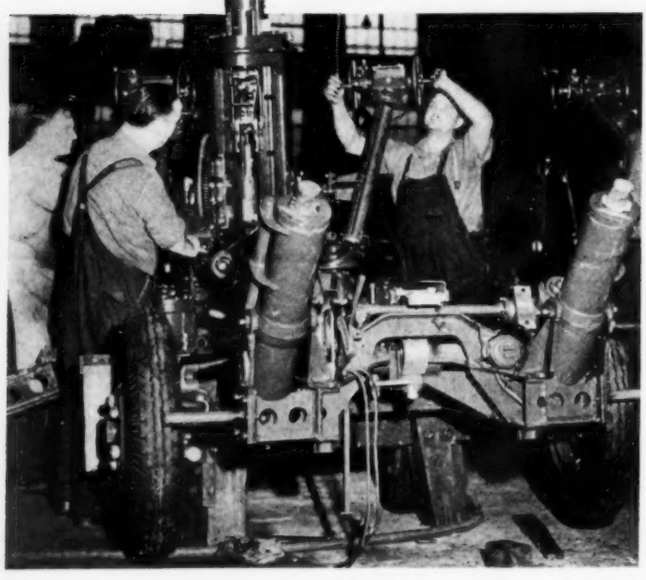

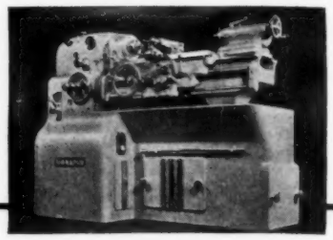

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ARMY ORDNANCE ASSOCIATION

WASHINGTON

A Membership Society of American Citizens
Dedicated to Industrial Preparedness for the
National Defense of the United States

Founded 1919

THE ORDNANCE ENDOWMENT

THIS INVITATION and the accompanying data are being sent to those companies now engaged in the production of military armament for the national defense of the United States. The purpose of the invitation is to ask contributions to the Ordnance Endowment—a permanent fund of at least half a million dollars now being raised to foster the design, development and production of military armament in the United States through industrial preparedness. The objectives of the Ordnance Endowment are described overleaf. Likewise is published the membership of the Committee on Endowment. Included is a form for the use of contributors.

OBJECTIVES OF THE ORDNANCE ENDOWMENT

THE Ordnance Endowment will be a permanent fund, title to which will be in the Army Ordnance Association—a nation-wide non-profit membership society for the advancement of industrial preparedness for the national defense of the United States—founded 1919, incorporated in the District of Columbia 1928. Administration of the Endowment will be by the Association through its duly elected officers and directors. The Endowment will be used:

1. To assist in effecting industrial preparedness for war as one of our nation's strongest guaranties of peace.

2. To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance matériel.

3. To encourage technical and scientific research for the development of military armament and its maintenance by our armed forces.

4. To promote mutual understanding and to effect cooperation with American scientists, inventors, engineers and manufacturers in civil life and the Army Ordnance Department.

5. To provide when required the services of competent committees to investigate and report upon special ordnance subjects.

6. To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for units required for Ordnance Field Service in the event of an emergency.

7. To commemorate the services rendered by the industry of the nation and by the officers and civilians of the Ordnance Department, U. S. Army, in the wars and defense emergencies in which the United States has been engaged.

8. To assist at all times the technical and scientific branches of the defense forces of the United States in any and all ways intended to enhance the national defense.

The Ordnance Endowment, following the uninterrupted policies of the Army Ordnance Association since its foundation in 1919, will not under any circumstances be used for any of the following purposes:

1. It will not be used to promote the commercial interests or obtain Government orders or contracts for any of its contributors or others at any time.

2. It will not be used to enhance the political designs or ambitions of any individual, company or group whether contributors or not.

3. It will not be used to influence legislation of any nature, national or local.

4. It will not be used to stimulate wars or rumors of wars for the development of markets for armament of any kind.

5. It will not be used to seek the monetary profit or otherwise of any individual, company or group.

6. It will not be used to engage in any activities other than those directly relating to the advancement of the national defense of the United States.

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